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ISO/NWI 10303

Product data representation and exchange – Application protocol: Furniture product data and project data

ABSTRACT:

This part of ISO 10303 documents the furniture and interior design project data, to be used predominantly in the relationship among manufacturers, suppliers and the end users, in the scope of the furniture industry. In terms of incorporated furniture sectors, this AP focus the kitchen and domestic furniture, and can be extended in order to cover the whole furniture domain (e.g., bathroom, boisserie, etc.).

KEYWORDS: Furniture, Decoration and Furnishing Project, Exchange of Furniture and Decoration Data

COMMENTS TO READER:

This document has been reviewed and noted by the ISO TC 184/SC4 Quality Committee and SC4 Secretariat and has been determined to be ready for this ballot cycle.

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document:

- an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;

- an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/PAS or ISO/TS is reviewed every three years with a view to deciding whether it can be transformed into an International Standard.

ISO 10303 consists of the following parts under the general title Industrial automation systems and integration - Product data representation and exchange:

— Part 1, Overview and fundamental principles;

— Part 11, Description methods: The EXPRESS language reference manual;

— Part 12, Description method: The EXPRESS-I language reference manual;

— Part 21, Implementation methods: Clear text encoding of the exchange structure;

— Part 22, Implementation method: Standard data access interface specification;

— Part 23, Implementation method: C++ language binding to the standard data access interface;

— Part 24, Implementation method: C language binding to the standard data access interface;

— Part 26, Implementation method: Interface definition language binding to the standard data access;

— Part 31, Conformance testing methodology and framework: General concepts;

— Part 32, Conformance testing methodology and framework: Requirements on testing laboratories and clients;

— Part 34, Conformance testing methodology and framework: Abstract test methods;

— Part 35, Conformance testing methodology and framework: Abstract test methods for SDAI implementations;

— Part 41, Integrated generic resources: Fundamentals of product description and support;

— Part 42, Integrated generic resources: Geometric and topological representation;

— Part 43, Integrated generic resources: Representation structures;

— Part 44, Integrated generic resources: Product structure configuration;

— Part 45, Integrated generic resource: Materials;

— Part 46, Integrated generic resources: Visual presentation;

— Part 47, Integrated generic resource: Shape variation tolerances;

— Part 49, Integrated generic resource: Process structure and properties;

— Part 101, Integrated application resource: Draughting;

— Part 104, Integrated application resource: Finite element analysis;

— Part 105, Integrated application resource: Kinematics;

— Part 106, Integrated application resource: Building construction core model;

— Part107, Engineering Analysis Core Application reference model (EA C-ARM);

— Part 201, Application protocol: Explicit draughting;

— Part 202, Application protocol: Associative draughting;

— Part 203, Application protocol: Configuration controlled design;

— Part 204, Application protocol: Mechanical design using boundary representation;

— Part 205, Application protocol: Mechanical design using surface representation;

— Part 207, Application protocol: Sheet metal die planning and design;

— Part 208, Application protocol: Life cycle management - Change process;

— Part 209, Application protocol: Composite and metallic structural analysis and related design;

— Part 210, Application protocol: Electronic assembly, interconnet, and packaging design;

— Part 212, Application protocol: Electrotechnical design and installation

— Part 213, Application protocol: Numerical control process plans for machined parts;

— Part 214, Application protocol: Core data for automotive mechanical design processes;

— Part 215, Application protocol: Ship arrangement;

— Part 216, Application protocol: Ship moulded forms;

— Part 217, Application protocol: Ship piping;

— Part 218, Application protocol: Ship structures;

— Part 221, Application protocol: Functional data and their schematic representation for process plant;

— Part 222, Application protocol: Exchange of product data for composite structures;

— Part 223, Application protocol: Exchange of design and manufacturing product information for casting parts;

— Part 224, Application protocol: Mechanical product definition for process plans using machining features;

— Part 225, Application protocol: Building elements using explicit shape representation;

— Part 226, Application protocol: Ship mechanical systems;

— Part 227, Application protocol: Plant spatial configuration;

— Part 229, Application protocol: Exchange of design and manufacturing product information for forged parts;

— Part 230, Application protocol: Building structural frame: Steelwork;

— Part 231, Application protocol: Process engineering data: Process design and process specification of major equipment;

— Part 232, Application protocol: Technical data packaging core information and exchange;

— Part 301, Abstract test suite: Explicit draughting;

— Part 302, Abstract test suite: Associative draughting;

— Part 303, Abstract test suite: Configuration controlled design;

— Part 304, Abstract test suite: Mechanical design using boundary representation;

— Part 305, Abstract test suite: Mechanical design using surface representation;

— Part 307, Abstract test suite: Sheet metal die planning and design;

— Part 308, Abstract test suite: Life cycle management - Change process;

— Part 309, Abstract test suite: Composite and metallic structural analysis and related design;

— Part 310, Abstract test suite: Electronic assembly, interconnect, and packaging design;

— Part 312, Abstract test suite: Electrotechnical design and installation;

— Part 313, Abstract test suite: Numerical control process plans for machined parts;

— Part 314, Abstract test suite: Core data for automotive mechanical design processes;

— Part 315, Abstract test suite: Ship arrangement;

— Part 316, Abstract test suite: Ship moulded forms;

— Part 317, Abstract test suite: Ship piping;

— Part 318, Abstract test suite: Ship structures;

— Part 321, Abstract test suite: Functional data and their schematic representation for process plant;

— Part 322, Abstract test suite: Exchange of product data for composite structures;

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— Part 326, Abstract test suite: Ship mechanical systems;

— Part 327, Abstract test suite: Plant spatial configuration;

— Part 329, Abstract test suite: Exchange of design and manufacturing product information for forged parts;

— Part 330, Abstract test suite: Building structural frame: Steelwork;

— Part 331, Abstract test suite: Process engineering data: Process design and process specification of major equipment;

— Part 332, Abstract test suite: Technical data packaging core information and exchange;

— Part 501, Application interpreted construct: Edge-based wireframe;

— Part 502, Application interpreted construct: Shell-based wireframe;

— Part 503, Application interpreted construct: Geometrically bounded 2D wireframe;

— Part 504, Application interpreted construct: Draughting annotation;

— Part 505, Application interpreted construct: Drawing structure and administration;

— Part 506, Application interpreted construct: Draughting elements;

— Part 507, Application interpreted construct: Geometrically bounded surface;
— Part 508, Application interpreted construct: Non-manifold surface;

— Part 509, Application interpreted construct: Manifold surface;

— Part 510, Application interpreted construct: Geometrically bounded wireframe;

— Part 511, Application interpreted construct: Topologically bounded surface;

— Part 512, Application interpreted construct: Faceted boundary representation;

— Part 513, Application interpreted construct: Elementary boundary representation;

— Part 514, Application interpreted construct: Advanced boundary representation;

— Part 515, Application interpreted construct: Constructive solid geometry;

— Part 517, Application interpreted construct: Mechanical design geometric presentation;

— Part 518, Application interpreted construct: Mechanical design shaded presentation;

— Part 519, Application interpreted construct: Geometric tolerances;

— Part 520, Application interpreted construct: Associative draughting.

The structure of this International Standard is described in ISO 10303-1. The numbering of the parts of the International Standard reflects its structure:

— Parts 11 to 12 specify the description methods,

— Parts 21 to 26 specify the implementation methods,

— Parts 31 to 35 specify the conformance testing methodology and framework,

— Parts 41 to 49 specify the integrated generic resources,

— Parts 101 to 106 specify the integrated application resources,

— Parts 201 to 232 specify the application protocols,

— Parts 301 to 332 specify the abstract test suites, and

— Parts 501 to 518 specify the application interpreted constructs.

Introduction

ISO 10303 is an International Standard for the computer-interpretable representation and exchange of product data. The objective is to provide a neutral mechanism capable of describing product data throughout the life cycle of a product, independent from any particular system. The nature of this description makes it suitable not only for neutral file exchange, but also as a basis for implementing and sharing product databases and archiving.

This International Standard is organized as a series of parts, each published separately. The parts of ISO 10303 fall into one of the following series: description methods, integrated resources, application interpreted constructs, application protocols, abstract test suites, implementation methods, and conformance testing. The series are described in ISO 10303-1.

This part of ISO 10303 specifies an Application Protocol (AP) for Furniture Product Definition (FPD) and Interior Design Project (IDP) data definition, to be used predominantly in the relationship among manufacturers, suppliers, retailers, decorators and general users, in the scope of the furniture industry for decoration and furnishing projects. In terms of incorporated furniture sectors, the AP is focused on the kitchen and domestic furniture, extensible to cover the whole furniture domain (e.g., bathroom, office, boisserie, etc.).

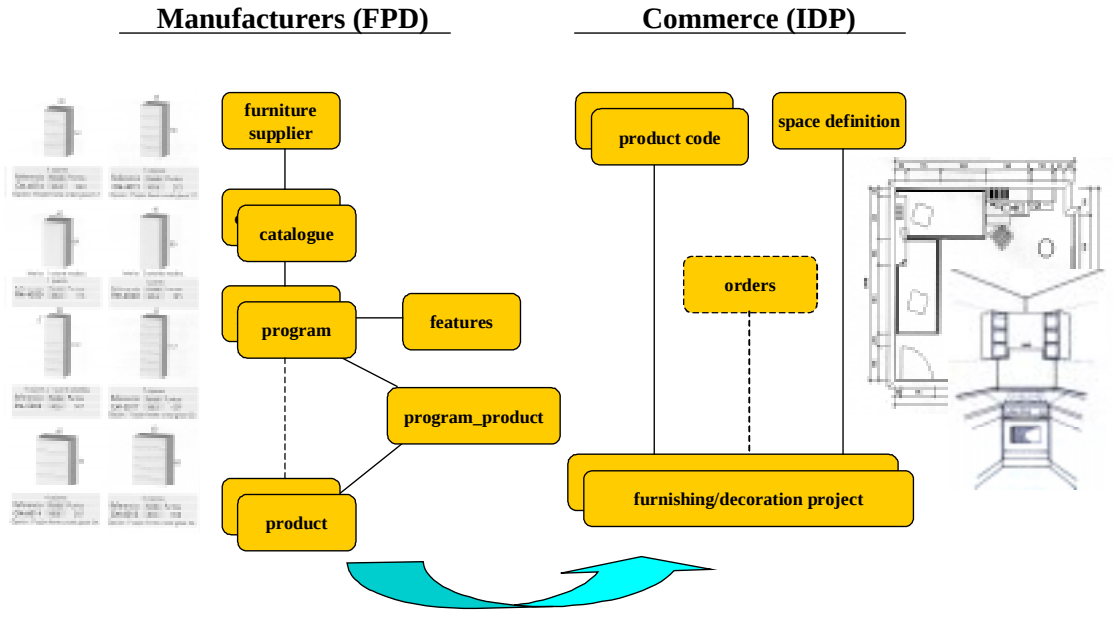


Figure 1– funStep AP model

This AP aim allows the exchange of product libraries (catalogues and decorating projects) and orders, including graphic information, covering the principal aspects related

with the furniture industry business. This AP intends to be the first of a sequence of possible APs to be proposed to ISO TC184/SC4 for the furniture industry to cover its requirements for data exchange and data sharing. These will cover retailers, major retailers, private customer and software houses demands and necessities.

Due to a potential enlargement of the AP, and when considered adequate, it can be modularised into different APs, for instance each one covering separately one single furniture subsector.

In 1998 the funStep Interest Group (FSIG) was set-up including almost 100 industrial and academic/research organisations coming from 15 countries world-wide, nowadays, the Group consists of 127 companies from 17 countries.

FSIG is a Users Group with the main purpose of co-ordinating the furniture and related industry towards the creation and industrial implementation of open standards in a bottom-up approach. Special attention is paid to the funStep data exchange structures. Group representatives are collaborating actively -or in some cases as listeners- with international and domestic standards bodies and projects. FSIG will bring a decisive contribution and support for the development and success of this AP.

Already organised consortia within the FSIG have been discussing the evolution of the existing models towards the implementation of a business-to-business e-commerce specification for furniture industry, considering the new implementations of EDI. News will be generated within the next months.

The 75% of FSIG membership consist of furniture manufacturers, retailers, industrial federations, and software vendors specialised in the furniture industry. Others are mainly research organisations and Universities.

The following figure shows the participation per organisation type.

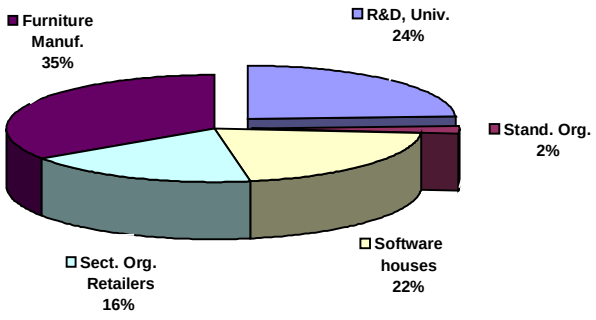


Figure 2 - FSIG participation per organisation type

The users of the product data exchange formats (software vendors, manufacturers and retailers) represent the 74% of the total Members of the funStep Interest Group. The other 26% consists of R&D organisations, Universities and Standardisation organisations with

a high level of expertise in the fields related to information technologies, data interchange and management, STEP, etc. They will be an excellent support team for the industrial Members.

Overlapping with other AP's

The scope of the proposed AP is on the data modelling requirements for furniture commercialisation. Thus, there is no overlapping with the existing ISO TC184/SC4 APs (IS or proposals for that), even considering the works in the field of Building & Construction.

The funStep AP is addressing the following 2 sections, and the following can be stated referring overlapping (for details, please see annex A):

1. **product and catalogue modelling**: No overlapping is identified because none representation to describe the product of furniture already exists in any of the ISO TC184/SC4 standards. Catalogues of furniture represent the products as a whole not requiring the detailed specification of parts as PLib does. Thus a lighter structure should be adopted.
2. **interior design and decoration/furnishing project modelling**: No overlapping is identified considering the scope of developments, although it is being planned to use the existent data structures within those APs related to B&C (e.g. the AP225) describing entities for space definition (i.e. "room", "wall") and facilities required in a furnishing project. The following picture represents the use of elements within the AP225

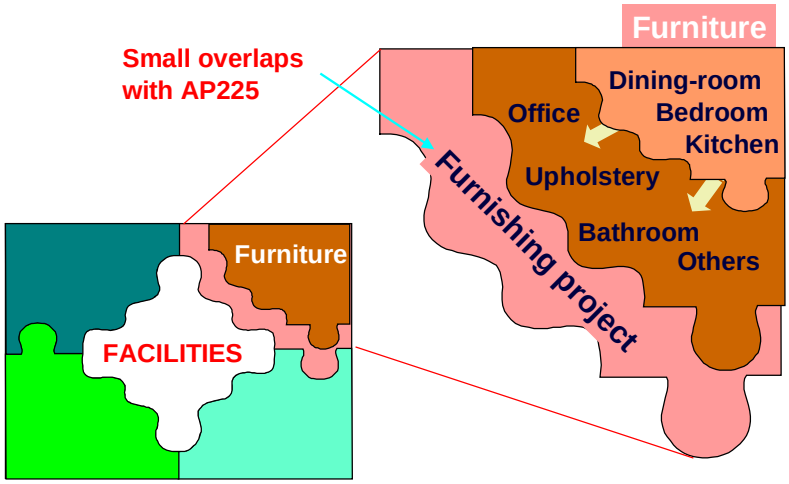


Figure 3 - Small overlap with part ISO 10303-225

Reuse will be strongly considered for these developments. Special care will be taken in order to co-ordinate the AP developments with SC4 WG3 T12 Building & Construction group in order to reuse all the entities related to the space definition in a furnishing project and do not duplicate and overlap.

The same applies to parts 42 and 46 - Integrated Generic Resources, and parts 201 and 225 – Application Protocols.

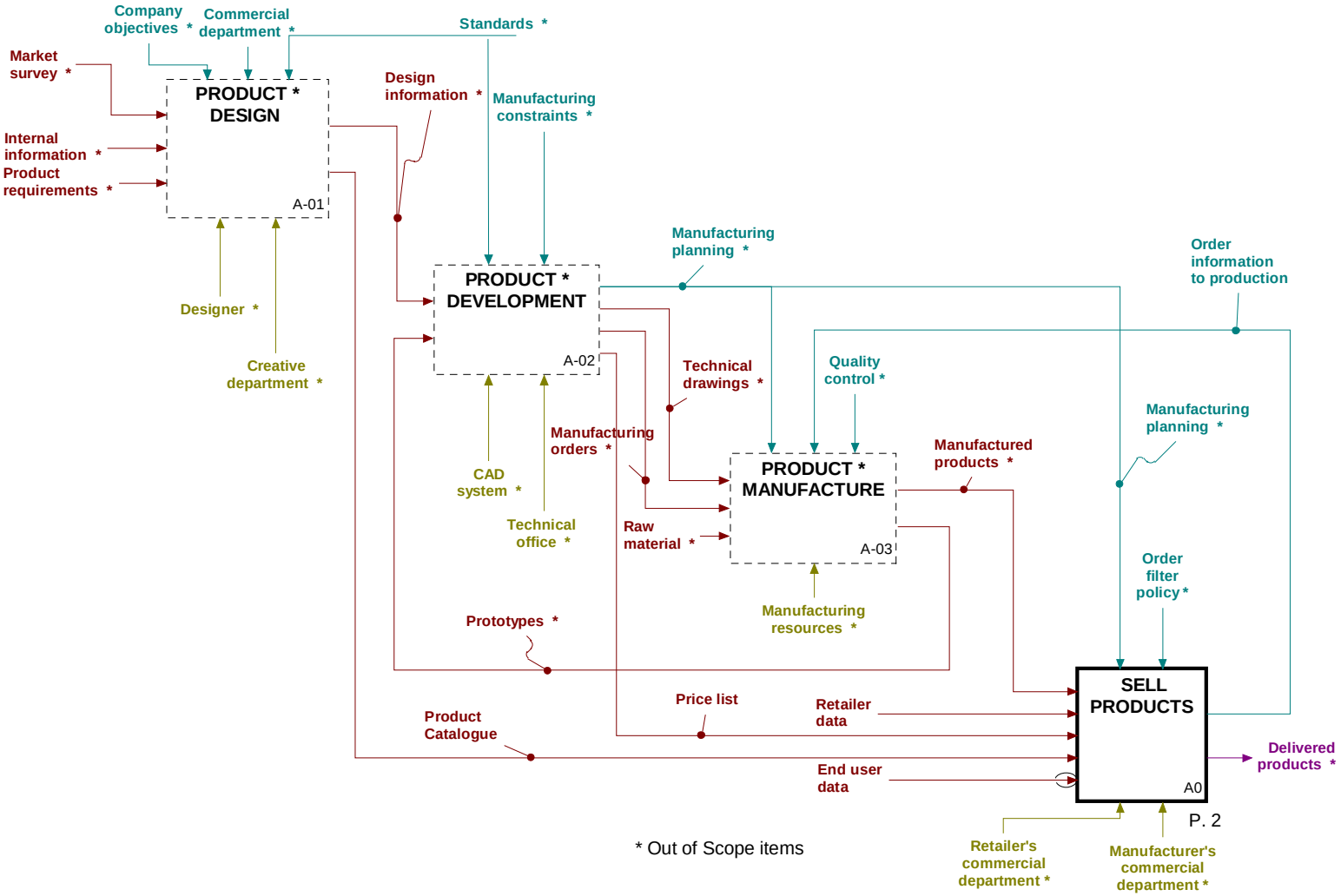


Figure 4 - IDF0 for the funStep AP - The context diagram

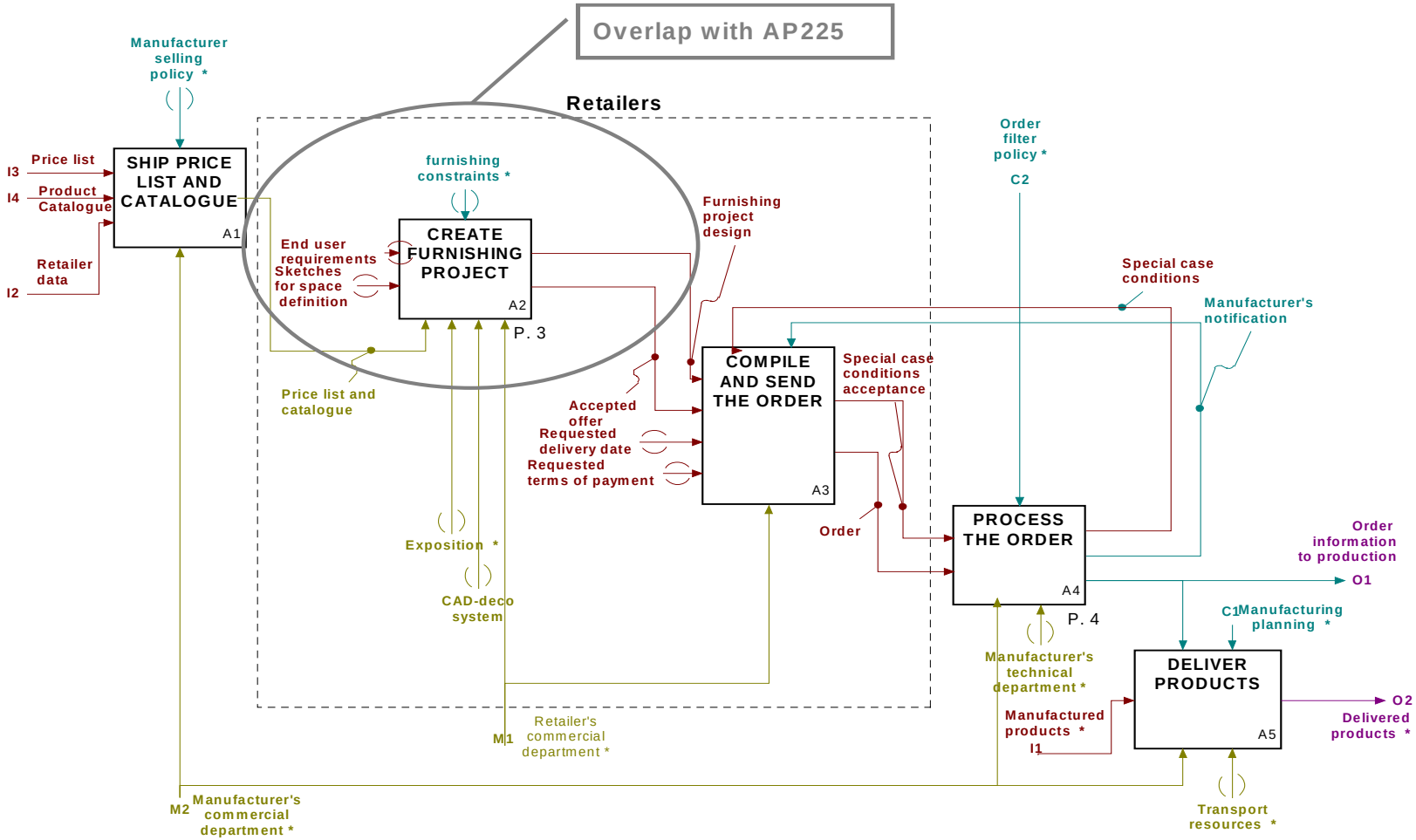


Figure 5 – IDEF0 for funStep AP – Sell Products decomposition. Ships price lists and catalogues to the Shops following the internal manufacturer's policy, the shop do the furnishing project, prepare and send the order to the manufacturer and the latter checks it and ships the products.

Industrial automation system and integration – Product data representation and exchange – Part : Application protocol: Furniture product data and project data - funStep AP

1. Scope

This part of ISO 10303 specifies the use of the integrated resources necessary for the scope and information requirements for the exchange of data among manufacturers, suppliers and the end-users (retailers, major retailers and private customers) in the furniture industry domain. This AP refers to product definition on kitchen and domestic furniture, extensible to cover the whole furniture domain (e.g., bathroom, office, boisserie, etc.), as described below:

- Decoration project
  - Definition
  - Parametrization
  - Room, wall and housing
  - Price
  - Date and time
- Product definition
  - Catalogue of products
  - Program groups of furniture
  - Description of components
  - Measure
  - Geometry
  - Topology
  - Finishing
  - Price
  - Accessories and appliances

in order to allow the exchange of Product Libraries (catalogues and decorating projects) and Orders, including graphical information.

There is a set of furniture suppliers/manufacturers that are related with a set of commerce in order to do business selling furniture pieces. Each manufacturer offers to the market products in one or several Catalogues and it is focused in one or several lines of products (furniture for dining-rooms, youth bedrooms, double rooms, kitchens, bathrooms, etc.). In

those lines of products there are one or several programs (or families) offered in the market, which provide different styles to the customers.

2. Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 10303. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 10303 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 8824-1:1994 *Information Technology – Open systems interconnection – Abstract syntax notation one (ASN.1) – Part 1: Specification of basic notation*.

ISO 10303-1: 1994. *Industrial automation systems and integration – Product data representation and exchange – Part 1: Overview and fundamental principles*.

ISO 10303-11: 1994. *Industrial automation systems and integration – Product data representation and exchange – Part 11: Description methods: The EXPRESS language reference manual*.

ISO 10303-21: 1994. *Industrial automation systems and integration – Product data representation and exchange – Part 21: Implementation methods: Clear text encoding of the exchange structure*.

ISO 10303-31: 1994. *Industrial automation systems and integration – Product data representation and exchange – Part 31: Conformance testing methodology and framework: general concepts*.

ISO 10303-41: 1994. *Industrial automation systems and integration – Product data representation and exchange – Part 41: Integrated generic resources: Fundamentals of product description and support*.

ISO 10303-42: 1994. *Industrial automation systems and integration – Product data representation and exchange – Part 42: Integrated generic resources: Geometric and topological representation*.

ISO 10303-43: 1994. *Industrial automation systems and integration – Product data representation and exchange – Part 43: Integrated generic resources: Representation structures*.

ISO 10303-44: 1994. *Industrial automation systems and integration – Product data representation and exchange – Part 44: Integrated generic resources: Product structure configuration*.

ISO 10303-45: 1994. *Industrial automation systems and integration – Product data representation and exchange – Part 45: Materials.*

ISO 10303-46: 1994. *Industrial automation systems and integration – Product data representation and exhange – Part 46: Integrated generic resources: Visual presentation*.

For the representation of catalogue data, ISO13584 “Parts Libraries” will be considered. Also, the work developed by the Parametrics group may be taken in account to support parametric features of furniture.

3. Definitions and abbreviations

3.1 Terms defined in ISO 10303-1

— application;

— application activity model (AAM);

— application interpreted model (AIM);

— application object;

— application protocol (AP);

— application reference model (ARM);

— conformance testing;

— implementation method;

— integrated resource;

— PICS proforma;

— Product;

— Product data;

— unit of functionality (UoF);

3.2 Terms defined in ISO 10303-31

This part of ISO 10303 makes use of the following terms defined in ISO 10303-31:

— abstract test suite (ATS);

— protocol information and conformance statement (PICS)

— conformance class;

3.3 Other definitions

For the purpose of this part of ISO 10303, the following definition(s) apply:

3.3.1 furnishing/decoration project

The information that constitutes a specification sufficient for the evaluation and manufacturing of a decorated room.

3.3.2 …

3.4 Abbreviations

For the purposes of this part of ISO 10303, the following abbreviations apply:

AAM	Application Activity Model
AP	Application Protocol
ARM	Application Reference Model
FPD	Furniture Product Definition
IDP	Interior Design Project
FSIG	funStep Interest Group
CAD	Computer Aided Design system
CAD2	Specialised CAD systems for furniture editing and furnishing interior design projecting

4. Information requirements

4.1 Units of Functionality

4.2 Application objects

4.3 Application assertions

5. Application interpreted model

5.1 Mapping table

5.2 AIM EXPRESS short listing

6. Conformance Requirements and Test Purposes

A AIM EXPRESS expanded listing

(normative)

B AIM short name of entities

(normative)

C Protocol Implementation Conformance Statement (PICS) proforma

(normative)

D Application activity model

(informative)

Table of Contents

D.1 Application Scope

D.1.1 Introduction

The application activity model (AAM) is provided to aid in the understanding the scope and information requirements defined in this application protocol. The model is presented as a set of definitions of both the activities and the data and a set of activity diagrams. It covers activities which go beyond the subject of this application protocol. The definitions given in this annex do not supersede the definitions given in the normative text. The diagrams use IDEFO notation (See annex H). A summary of the interpretation of the arrows connected to each activity box is given in figure F.I. Each activity may be decomposed to provide more detail. If an activity has been decomposed, a separate figure is included.

D.1.1.1 Diagram syntax and usage

An IDEF0/SADT diagram contains boxes and arrows. The boxes represent activities of the system being modeled. Arrows connect boxes together and represent interfaces or interconnections between the boxes.

Boxes are rectangles, represent a function or an active part of the system, so are named with verbs or verb phrases. No fewer than 3 and no more than 6 boxes appear on any one diagram.

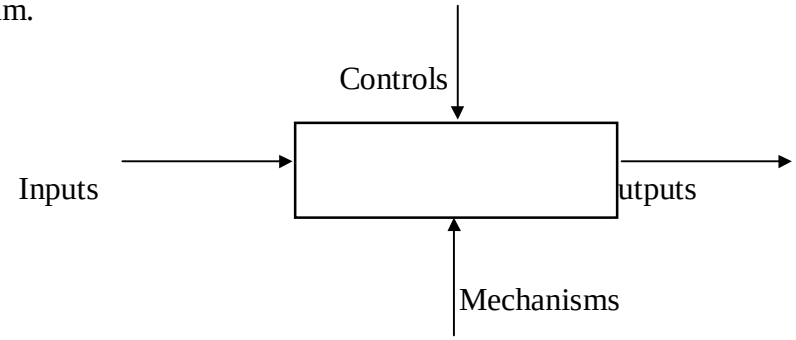


Figure 6 - IDEFO basic notation

Boxes are placed in the diagram according to their relative order of importance, their “dominance”. Usually the most dominant box is placed in the upper left-hand corner of the diagram. Dominance can be thought of as the influence one box has over other boxes. Also dominance can be indicated by a digit placed in the lower right-hand corner of each rectangle.

Arrows are single lines with arrowheads at their ends, they represent “things”, so, they are labeled with nouns or noun phrases. Arrows are collections of things, they can have multiple tails(sources) and multiple heads(destinations).

A diagram is usually redrawn several times, creating versions. IDEF0/SADT uses a diagram configuration control schema, built upon chronological numbers or C-numbers to distinguish different versions of the same diagram from each other. These codes are put in the lower right-hand corner, it is constructed from the author’s initials and a unique sequence number.

A system is represented by a single box and his arrows to define the boundary around the system. It is called “Context Diagram”.

The process of structured decomposition first breaks the one-box boundary of the model into a single diagram having from 3 to 6 boxes, then breaks one ore more of this boxes, and so on. The tittle for each diagram is taken verbatim from the box it decomposes.

IDEF0/SADT identifies each diagram in a particular model by what is called a “node number”. It has the form: model name or abbreviation, slash, the capital letter A (for Activity diagram),a hyphen, and zero, for example, MP/A-0. The node number for the diagram that decomposes the boundary is the same node number without the hyphen, MP/A0. All other node number are formed by taking the node number of the parent diagram and appending to it the number of the box that is being decomposed.

C-numbers are use also to link downward diagrams. In the Context area the author draws a tiny square for each box on the parent diagram, shades in the box that the diagram decomposes and place the c-number of the parent diagram near the shaded box.

IDEF0/SADT has a notation that allows identify and validate arrow connections between diagrams. It is a encoding Schema called ICOM (Input Control Output Mechanism)
by following it one creates a set of implicit off-page connectors which can be quickly changed when boundary changes.

As with any IDEFO model, the application activity model is dependent on a particular viewpoint and purpose. The viewpoint of the application activity model is from a design engineer. The purpose of the application activity model is to clarify the context and scope of this application protocol.

D.1.1.2 The modeling Process

IDEF0/SADT is a true methodology because it integrates an interactive process for model development, configuration control notation for models, a diagram reference language and a model activation language. Its organization is centered on the specific roles people play on IDEF0/SADT projects:

- experts are information sources
- authors develop diagrams and models
- a librarian coordinates the written exchange of information
- readers review and validate data models
- Technical Review Committee approves a model for usage

D.1.1.3 The funStep AAM

The application activity model consists of a structured graphical representation of the main activities developed within the application scope and the information, materials and

resources of such activities. IDEF0/SADT is the methodology used for the development of the Application Activity Model.

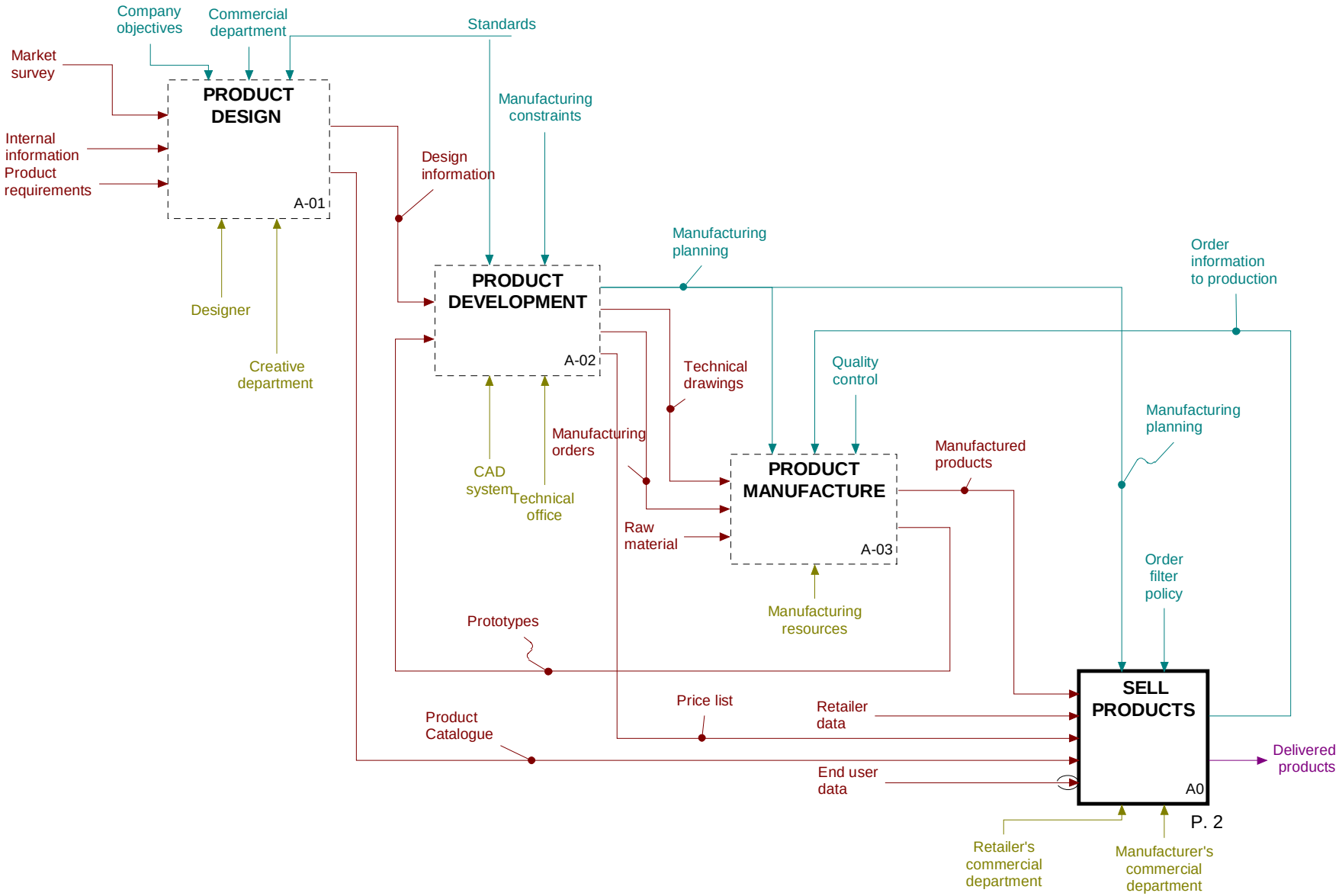
The model to describe has to be with the relationship among the furniture manufacturers and the commerce (retailers, major retailers and private customers).

The model refers to the Product definition to use in the Project model in order to allow the exchange of Product Libraries and Orders (decorating projects) including graphic information.

The purpose of the AAM model is the “Identification of the more important activities that are carried out in the manufacturer-customer relationship, in order to identify the most important information exchange between them”.

The aim of IDEF0 model is to provide a global vision of the activities to be performed in the system, the information flow and the required material.

The diagrams shown below contain the graphical model information. Activities with dashed line are out of the scope of interest of the system but are kept to give a global environmental view of the system.


Company objectives
Commercial department
Standards
Market survey
PRODUCT DESIGN
A-01
Internal information
Product requirements
Manufacturing constraints
Design information
Designer
Creative department
Manufacturing planning
Order information to production
PRODUCT DEVELOPMENT
A-02
Technical drawings
Quality control
Manufacturing planning
Manufacturing orders
CAD system
Technical office
Manufactured products
PRODUCT MANUFACTURE
A-03
Raw material
Order filter policy
Manufacturing resources
Prototypes
SELL PRODUCTS
A0
Price list
Retailer data
Product Catalogue
Delivered products
End user data
Retailer's commercial department
Manufacturer's commercial department

P. 2

D.1.2 A-0 node. Context Diagram

The context diagram is shown above. A description of each of its activities, inputs, outputs, resources and control items follows. Only activities in scope are described.

D.1.2.1 Activity: Product Design (A-01)

This activity has as objective the definition of the requirements of a new product covering an analysis of the today-situation of the company and its products. It also has into account the related standards.

Commercial and Creative departments are involved and sometimes external designers are contracted for the occasion. From a conceptual point of view, in the product design several aspects must be kept in mind such as manufacturing, assembly and recycling.

The Design information is generated for the following phase, product development and also the Catalogue.

D.1.2.2 Activity: Product Development (A-02)

This activity of product development allows to document technically the design producing technical drawings. Sometimes prototypes are required for production.

CAD/CAE systems make easy the documentation for the manufacturing phase. Once the design is approved the price lists are prepared.

There is collaboration between the Technical office and the Manufacturing department in this phase

D.1.2.3 Product Manufacture (A-03)

This is an activity of material and data processing, its objective is to obtain the final product with the requirements of quality defined.

It begins at the end of the previous phases with the input of row material, base material for the final product.

This activity consists of production programming, process planning and product manufacturing.

Technical drawings are the information generated during design and developing.

Manufacturing resources are human resources (CNC operator, programmer, etc.) and physical resources (CNC machinery, CAD/CAE systems, tools, etc.) necessary for product manufacturing.

The order information corresponds to the data in the order document asking for the product manufacturing, with delivery date, terms of payment, ship conditions, etc.

D.1.2.4 Activity: Sell Products (A0)

The product, when produced and controlled, is shipped to the Retailer as indicated in the shipping orders.

The activity of selling Products -pieces of furniture- (called in previous versions Manufacturer-Customer relationship) has been modeled with the activity named "Sell Products", and it stands for that period since a catalogue is sent to the Retailer until the purchase confirmation is received by the manufacturer from the Retailer. This purchase confirmation will make that the manufacturer launches a production order.

"**End-user**" refers to the client of the Shop, the person who is purchasing the pieces of furniture, the furniture buyer.

"**Retailer**" refers to the Shop but it can be a private customer sometimes (end-user as customer). Furniture manufacturers are their providers.

"**Manufacturer**" refers to the furniture manufacturer, who is supplier of the Shops or private customers (direct sale). Retailers are clients of the manufacturers

"**CAD-deco**" refers to the Computer Aided Design for furnishing in the Shop or at manufacturer's.

"**Special-case-conditions**" when an Order includes special products, they have a technical construction proof and an special budget calculation that is sent to the Shop with the delivery date to be accepted.

"**Manufacturer's notification**" an acceptance or rejection notification to the Shop.

"**Order**" usually sent via fax to the manufacturer from the Retailer. It consists of 3 parts basically:

- Retailer's management data; address, name, etc.
- Design; the view plans needed to describe the project completely
- Article description; quantity, code, description, price, etc.

When the Project contains special products (products that are not catalogued products) it can add sketches indicating dimensions, notes, etc.

A. Activity Inputs:

- **Retailer data:** They comprise the name, code and address data from the Retailer's
- **End user data:** They comprise the name, code and address data from the end user
- **Price lists:** They are the fees with all the article data; name, code, dimensions, price and a draw and other characteristics

- **Product catalogue:** It consists of a collection of photographs and other indications to show an extract of all the possibilities of the manufacturer's products

- **Manufactured products:** Products ready for shipping following the order indications and data

B. Activity Outputs:

- **Order information to production:** Once the order from the Retailers' has been filtered and everything has been checked, this notification with the order data starts all the Production process for the products to be produced, packaged and shipped.

C. Activity Controls:

- **Order filter policy:** This is the set of restrictions and controls for an order to be introduced in the manufacturer's system. It is credit policy and sometimes management decisions. Each manufacturer company uses this criteria in a very personal way. It is the set of technical and credit filters an order has to pass before the rejection or acceptance process.

- **Manufacturing planning:** This is the control that allows the selling product activity to take place, including information about delivery and expedition

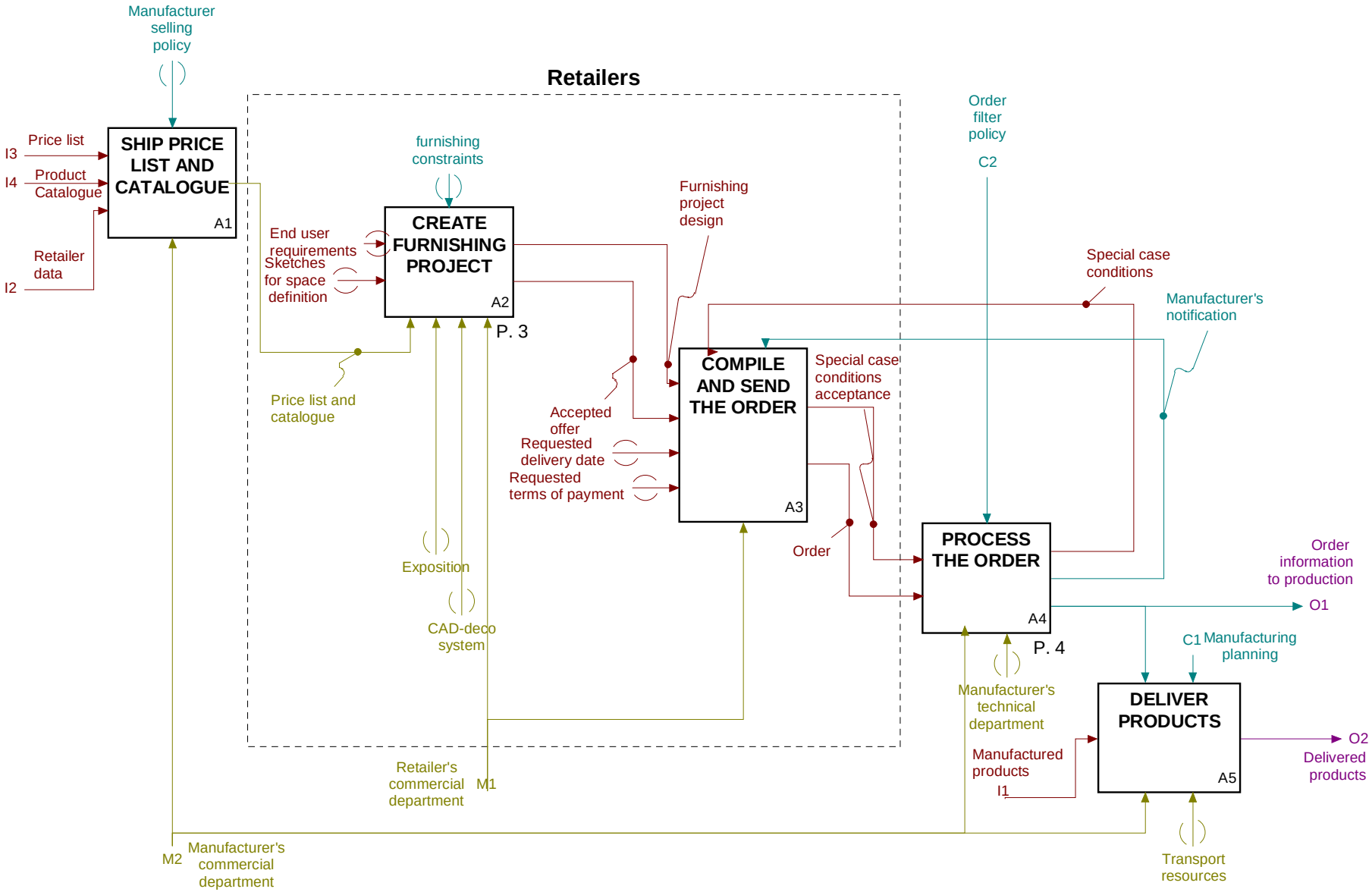
D. Activity Mechanism:

- **Retailer's commercial department:** Personnel responsible at the shop of running the selling, create the furnishing project with the manufacturer's information and prepare the order to the manufacturers'

- **Manufacturer's commercial department:** Personnel responsible of the distributions of the commercial information to their clients and filter and compile the orders information.

D.1.3 A0 node. Sell Products

The produced and controlled products are distributed to the shops following the delivery orders


Manufacturer selling policy
Retailers
Price list
I3
Product Catalogue
I4
Retailer data
I2
SHIP PRICE LIST AND CATALOGUE
A1
furnishing constraints
CREATE FURNISHING PROJECT
A2
P. 3
End user requirements
Sketches for space definition
Furnishing project design
Order filter policy
C2
Special case conditions
Manufacturer's notification
Price list and catalogue
COMPILE AND SEND THE ORDER
A3
Special case conditions acceptance
Accepted offer
Requested delivery date
Requested terms of payment
Order
PROCESS THE ORDER
A4
P. 4
Order information to production
O1
Exposition
CAD-deco system
C1 Manufacturing planning
Manufacturer's technical department
DELIVER PRODUCTS
A5
O2
Delivered products
Manufactured products
I1
Retailer's commercial department
M1
M2
Manufacturer's commercial department
Transport resources

D.1.3.1 Activity: Ship price list and Catalogue (A1)

This activity ships the fees and catalogues to the Shops following the internal manufacturer's policy. Nowadays it is carried out by mail, in diskette or CD but it is intended to get the information in the future from the www through Internet services.

A. Activity Inputs:

- **Price lists:** (page. 5)
- **Product catalogue:** (page 5)
- **Retailer data:** (page 5)

B. Activity Outputs:

- **Price list and catalogue:** The manufacturer's information (price list and catalogue) arrives to the Retailers and they will use it as a resource for their work.

C. Activity Controls:

- **Manufacturer selling policy:** Rules for delivering their information to the different clients (retailers) they have depending on the area, relationships, etc.

D. Activity Mechanism:

- **Manufacturer's commercial department:** Personnel responsible of the distributions of the commercial information.

D.1.3.2 Activity: Create furnishing project (A2)

In this activity it is assumed the Retailer has a CAD-deco system in his local to allow the furnishing project to be developed using the information from the manufacturers they work with. The end user is the person who buys the products at the shop giving his requirements to the shop commercial assistant and studying the budget proposed.

A. Activity Inputs:

- **End user requirements:** Oral information from the buyer with indications of the style, materials, colours, etc. he would like to buy.
- **Sketches for space definition:** It can be in several ways; technical drawings of the room to furnish, hand made sketches or oral information from the buyer

B. Activity Outputs:

- **Furnishing project design:** Different views of the furnished room/s, front, top, perspectives, details with the information to define the required products clearly in the virtual context they are going to be placed.

- **Accepted offer:** When the furnishing process is over, all the required pieces of furniture are placed, the budget is proposed to the end user in an offer. If it is not accepted by the end user then it is possible to do a modification and the furnishing process is repeated.

C. Activity Controls:

- **Furnishing constraints:** Rules for creating the design; ergonomics, aesthetic, functional, etc.

D. Activity Mechanism:

- **Retailer's commercial department:** Personnel responsible of the design project creation.

- **Price list and catalogues:** Output from the A1 node.

- **Exposition:** A brief sample of different manufacturer's products present at the shop to allow end users having an idea of materials, quality, etc.

- **CAD-deco system:** PC or workstation system with the furnishing software from a vendor. It contains the updated libraries from the manufacturers they work with. It produces design project and budget.

D.1.3.3 Activity: Compile and send the order (A3)

With the offer accepted by the end user, the retailer's commercial department prepare the order to the manufacturer. It usually consists of their own data (address, VAT number,…) the technical plans of the furnishing room and the requested delivery date, terms of payment, etc.

A. Activity Inputs:

- **Furnishing project design:** Output from A2

- **Accepted offer:** Output from A2

- **Requested delivery date:** It is the date the Retailer supposes the good can be delivered to the end user

- **Requested terms of payment:** They are the terms of payment agreed with the manufacturer

B. Activity Outputs:

- **Special case conditions acceptance:** When a project has "special" products, out of catalogue; with cuts, horizontal, vertical, -both longer or shorter than usual-, with a different shape, etc., the budget is calculated based on manufacturer's rules and most cases the budget is produced by the commercial manufacturer's department. Then this acceptance notification is sent to the manufacturer.

- **Order:** With the end-user accepted order, the requested data and design information, the order is prepared with the help of the CAD-deco system to obtain the budget and the views needed for the particular project. Then the Order is sent to the manufacturer via fax or mail usually (later on, it is intended to be available in the web server)

C. Activity Controls:

- **Manufacturer's notification:** Message from the manufacturer indicating if the project is accepted or rejected.

D. Activity Mechanism:

- **Retailer's commercial department:** Personnel responsible of the creation of the design project and compiling and sending the order.

D.1.3.4 Activity: Process the order (A4)

The manufacturer gets the Order and according to his commercial rules and production limitations he will inform the customer if his proposal will be accepted (manufacturer's notification). It will accomplish by sending either a positive notification or a "Rejected Order Form". The rejection can be because of credit or technical reasons. This answer will produce a control feedback to the customer when he wants to make projects.

In case of special products the budget and delivery date are sent to the Retailer, he will have to decide if he accepts it or not; in the first case the customer sends the acceptance and the manufacturer launches the production order, in other case the customer would modify the original project.

A. Activity Inputs:

- **Special case conditions acceptance:** Output from A3

- **Order:** Output from A3

- **Manufactured products:** Output from A-03. Pieces of furniture to be distributed.

B. Activity Outputs:

- **Special case conditions:** Special budget for special products including delivery date
- **Manufacturer's notification:** It can be positive, credit and technical constraints are correct or negative
- **Order information to production:** It is a control for Product manufacturing (A-03). It starts the Production process.

C. Activity Controls:

- **Order filter policy:** It is the set of filters; technical, credit an order suffers before the rejected or accepted process .

D. Activity Mechanism:

- **Manufacturer's commercial department:** Personnel responsible of the filter and process of order from the retailers.
- **Manufacturer's technical department:** Personnel responsible of the technical verification of the order and the treatment in case of special projects.

D.1.3.5 Deliver products

This activity has as input the manufactured products and allows their distribution using the transport resources following the manufacturing planning instructions.

A. Activity Inputs:

- **Manufactured products:** Output from A-03

B. Activity Outputs:

- **Delivered Products:** Products shipped to the Retailer following the distribution strategy.

C. Activity Controls:

- **Manufacturing planning:** It is the set instructions with the distribution routes, controls and transport indications.
- **Order information to production:** it is a control for product manufacture activity to take care and also an indication for the delivery activity.

D. Activity Mechanism:

- **Manufacturer's commercial department:** Personnel responsible of the filter and process of order from the retailers.

- **Transport resources:** vehicles available in the company for expedition and transport of the products to Retailers.

Some nodes have been decomposed to make easy the understanding and to show the relevant ICOM's.

D.1.4 A2 node. Create furnishing project

A Retailer will develop a project (create a design) under request of an end user, in order to send them to the manufacturer. Projects can be either standard or special.

There is a set of sequential activities that are carried out in the process of selling pieces of furniture:

1. Capture end user information.
2. CAD library selection.
3. Position objects for composition.

Non lineal items are defined specially for any composition (plinths, worktops, cornices,..), they are used more often in kitchen furniture.

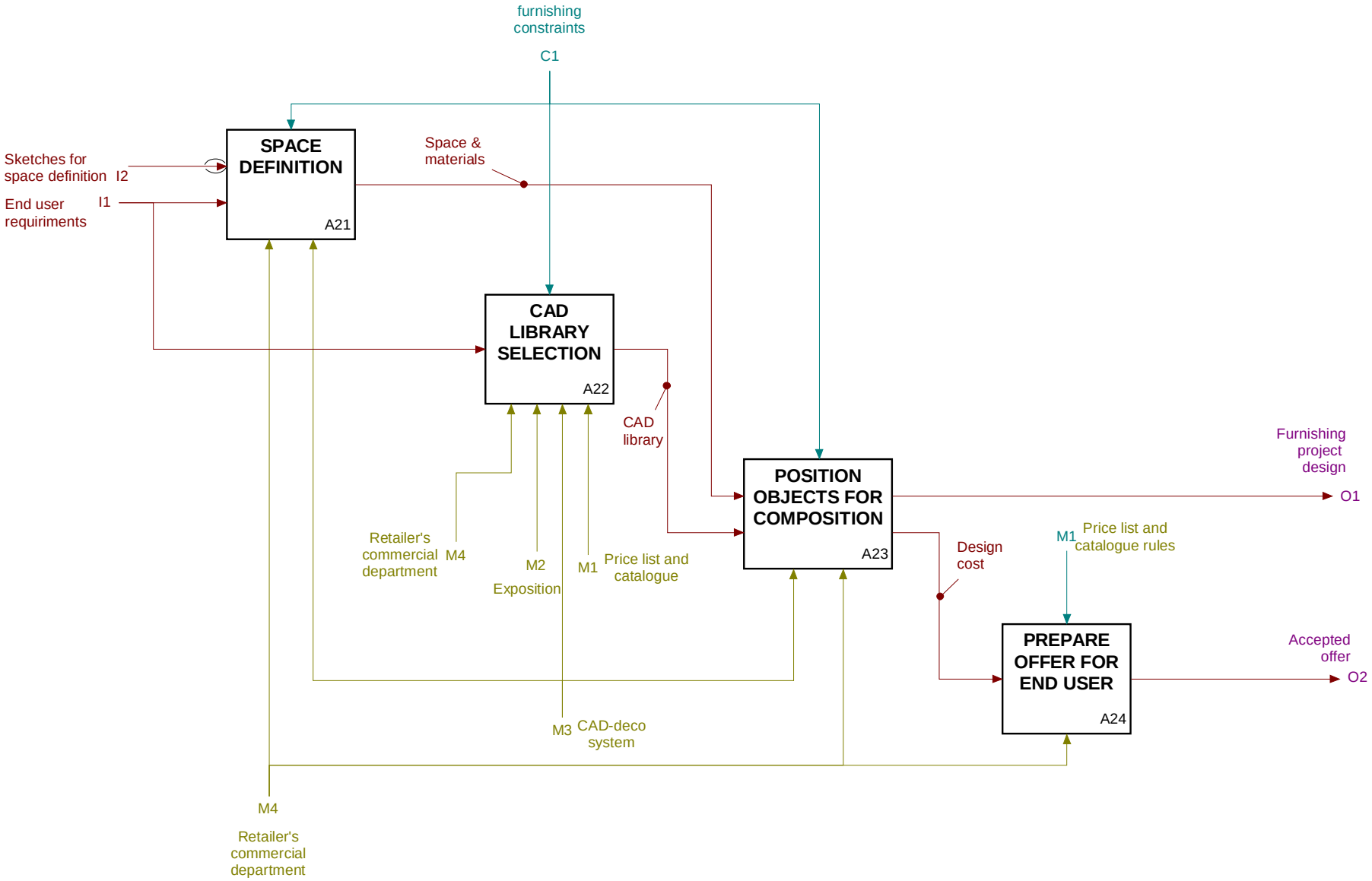
The **furnishing process** consists of locating the selected items based on the locating laws, rules provided in the manufacturers catalogues, i.e. locate pilaster between modules.

As the items are located the budget is generated in the background and can be consulted at any time. Modifications can be carried out based on design or budgetary arguments.

As a result is get in any case the following:

1. The **furnishing project design** with the resulting furnishing process (orthogonal views; top, front, sections, perspective views, details,…)

2. One **offer** to the end user with the proposal of the budget, generated automatically by the CAD-deco system.


furnishing constraints
C1
SPACE DEFINITION
A21
Sketches for space definition
I2
End user requiriments
I1
Space & materials
CAD LIBRARY SELECTION
A22
CAD library
POSITION OBJECTS FOR COMPOSITION
A23
Furnishing project design
O1
Retailer's commercial department
M4
M2
Exposition
M1
Price list and catalogue
Design cost
M1
Price list and catalogue rules
PREPARE OFFER FOR END USER
A24
Accepted offer
O2
M3
CAD-deco system
M4
Retailer's commercial department

D.1.4.1 A21 node. Space definition.

First of all there is a capture of the end user information. The shop assistant gets information from the end user orally or by sketches. With this information the system is able to define space (shape and measures) introducing real dimensions, identifying walls, doors, windows and accidents and defining material qualities for floor, ceiling, doors, etc. The end user product type is also identified thanks to objects in exposition and catalogue photographs.

A. Activity Inputs:

- **End user requirements:** Oral information from the buyer with indications of the style, materials, colours, etc., he has intention to buy.

- **Sketches for space definition:** It can be in several ways; technical drawings of the room to furnish, hand made sketches or oral information from the buyer

B. Activity Outputs:

- **Space and materials:** with the end user information space is defined (shape and measures) introducing real dimensions, identifying walls, doors, windows and accidents and defining material qualities for floor, ceiling, doors, etc.

C. Activity Controls:

- **Furnishing constraints:** It comprises all the rules imposed by any manufacturer and the CAD-deco systems can control (locating rules, joining rules between pieces, dimension rules, etc.)

D. Activity Mechanism:

- **Retailer's commercial department:** Personnel responsible of end user data collection referring to space definition.

- **CAD-deco system:** refers to the Computer Aided Design for furnishing in the Shop or at manufacturers'. It consists of a computer and the suitable software.

D.1.4.2 A22 node. CAD library selection

The CAD library selection process depends on the CAD-deco system used, but in general, it is carried out in several steps:

- Select the catalogue, through a selection tree; furnishing type or product line (Youth bedroom, boisserie, kitchen, bedroom, bathroom, office, dining-room, etc.)
- Select the manufacturer from the available libraries in the retailer's system (Ros-1, Nobilia, Puchades, Vaquer, …)
- Select the program. Each manufacturer groups their products in different catalogues. All the items in a program have similar attributes (Symbol, Compac, Issola, …)

- Select the finishing. It refers to the style usually (frame, plain, moulding) of the front division of the pieces of furniture. Some manufacturers use it for different colours (walnut, pine, cherry,….) or different types of handles (plain, ball, shell,…)

A. Activity Inputs:

- **End user requirements:** Oral information from the buyer with indications of the style, materials, colours, etc. he wants to buy.

B. Activity Outputs:

- **CAD library:** Selection of furniture manufacturer, product line and style. The CAD library items are available to begin the furnishing

C. Activity Controls:

- **Furnishing constraints:** It comprises all the rules imposed by whatever manufacturer and that the CAD-deco systems can control (selection tree, manufacturers and styles available, etc.)

D. Activity Mechanism:

- **Retailer's commercial department:** Personnel responsible of end user data collection referring to library selection.
- **CAD-deco system:** refers to the Computer Aided Design for furnishing in the Shop or at manufacturers. It consists of a computer and the suitable software.
- **Exposition:** A brief sample of different manufacturer's products present at the shop to allow end users having an idea of materials, quality, etc.
- **Price list and catalogue:** The manufacturer's information (price list and catalogue) from all the manufacturers the retailer works with, used as the basic elements to control the budget generation and items selection

D.1.4.3 Node A23. Position objects for composition

The activity position objects for composition allows to furnish the desired room. Available Library items are used from the selected catalogue together with the space information defined by the end user. For a new composition each item is selected, his position in the room and measures are indicated.

The items can be taken from the manufacturer catalogue, "standard" items or defined for the actual composition with particular features, non lineal items. Standard items has basic attributes:

- Surrounding dimensions (height, width, depth)
- Box / Front division
- Materials (finishing)
- Fixed (dimensions changes are not allowed) / Special

A. Activity Inputs:

- **CAD library:** Output from A22
- **Space & materials:** Output from A21

B. Activity Outputs:

- **Furnishing project design:** Different views of the furnished room/s. front, top, perspectives, details with the information to define clearly the required products in the virtual context they are going to be.
- **Design cost:** Budget proposed to the end user with the total cost of the items placed in the room until that moment.

C. Activity Controls:

- **Furnishing constraints:** It comprises all the rules imposed by any manufacturer and that the CAD-deco systems can control (price list rules, etc.)

D. Activity Mechanism:

- **Retailer's commercial department:** Personnel responsible of furnishing using the CAD-deco system.
- **CAD-deco system:** refers to the Computer Aided Design for furnishing in the Shop or at manufacturers. It consists of a computer and the suitable software.

D.1.4.4 Node A24. Prepare offer for end user

As the items are located the budget is generated in the background and can be consulted at any time. Modifications can be carried out based on design or budgetary arguments.

A. Activity Inputs:

- **Design cost:** Output from A23

B. Activity Outputs:

- **Accepted offer:** When the furnishing process is over, all the required pieces of furniture are placed, the budget is proposed to the end user in an offer. It is possible to do a modification and repeat the furishing process if it is not accepted by the end user. When the offer is accepted by the end user finally, it is used to prepare the order to the manufacturer.

C. Activity Controls:

- **Price list and catalogue rules:** It comprises all the rules imposed by any manufacturer and that the CAD-deco systems can control (price list rules, etc.). The CAD-deco system generates automatically the offer controlled by this rules.

D. Activity Mechanism:

- **Retailer's commercial department:** Personnel responsible of end user offer preparation.

- **CAD-deco system:** refers to the Computer Aided Design for furnishing in the Shop or at manufacturers. It consists of a computer and the suitable software.

D.1.5 A4 node. Process the order

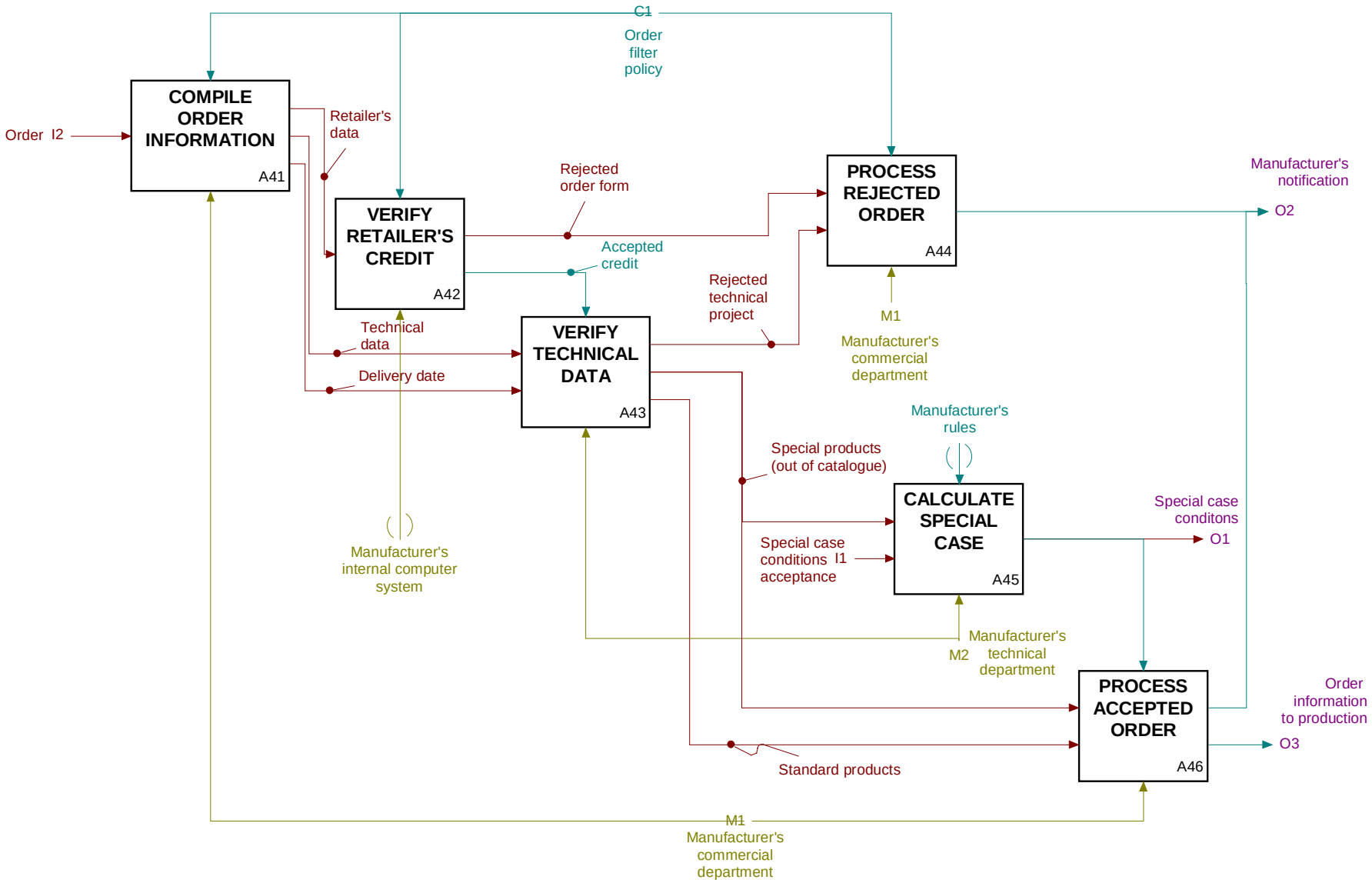
When the Order arrives (usually via fax or mail) there is an activity called "Compile Order information" that allows to explode the Order in several parts:

1. Customer Data goes to the "Verify Customer Credit" activity
2. Design; views and sketches information
3. Delivery date

Design and Delivery-data are sent to the "Verify Technical Data" activity.

The activities "Verify Customer Credit" and "Verify Technical Data" consist of the evaluation of the usual filters the orders pass in the firms. Those filters have been separated in technical -or those that the order pass concerning the product information- and commercial -those related with the customer credit and general conditions-. If none of the filters are passed there is a feedback sent to the customer with the information. If the filters are passed the customer gets a notification and the order is passed to the Production department of the manufacturers'.

When a design has special products, the activity "Calculate Special case" takes part sending a special-case notification to the customer with the budget and delivery date. It has to be accepted by the retailer, then the process continues in the same way than with a standard project.


C1
Order filter policy
COMPILE ORDER INFORMATION
A41
Order I2
Retailer's data
VERIFY RETAILER'S CREDIT
A42
Rejected order form
Accepted credit
PROCESS REJECTED ORDER
A44
Manufacturer's notification
O2
M1
Manufacturer's commercial department
Rejected technical project
Technical data
Delivery date
VERIFY TECHNICAL DATA
A43
Manufacturer's internal computer system
Manufacturer's rules
Special products (out of catalogue)
CALCULATE SPECIAL CASE
A45
Special case conditons
O1
Special case conditions I1 acceptance
M2
Manufacturer's technical department
PROCESS ACCEPTED ORDER
A46
Order information to production
O3
Standard products
M1
Manufacturer's commercial department

D.1.5.1 Node A41. Compile order information

The order filter policy of each manufacturer is used to select the processable orders. The order information is divided into several parts depending on the next treatment.

A. Activity Inputs:

- **Order:** See page 8

B. Activity Outputs:

- **Retailer's data:** Retailer's information; name, code, address, VAT number, etc., with the credit data.
- **Technical data:** Information for the project to be develop, drawings, material indications, sketches, etc.
- **Delivery date:** Date when the project is intended to be served to the Retailer.

C. Activity Controls:

- **Order filter policy:** It is the set of technical and credit filters an order suffers before the rejection or acceptance process.

D. Activity Mechanism:

- **Manufacturer's commercial department:** Personnel responsible of the filter and process of orders from the retailers.

D.1.5.2 Node A42. Verify Retailer's credit

Each manufacturer has a customer data base with the relevant data from each retailer, updating periodically their data.

A. Activity Inputs:

- **Retailer's data:** Output from A4

B. Activity Outputs:

- **Rejected order form:** In case the retailer is a slow payer or has other difficulties with the manufacturer, the order is sent to the process rejected form activity.
- **Accepted credit:** When the Retailer is up to date in paying. It is a control for the verify technical data activity although some manufacturers decide it at the end of the process.

C. Activity Controls:

- **Order filter policy:** It is the set of credit filters that passes an order before the rejection or acceptance process.

D. Activity Mechanism:

- **Manufacturer's internal computer system:** General software for administration and production management.

D.1.5.3 Node A43. Verify technical data

All the data are checked once the technical information is isolated, first of all the completeness of data and possible coding errors, later, the technical feasibility.

A. Activity Inputs:

- **Technical data:** Output from A42
- **Delivery date:** Output of A41

B. Activity Outputs:

- **Rejected technical project:** In case the project cannot be produced, the order is sent to the process rejected form activity.
- **Standard products:** When the project consists of standard product, from the catalogue a completeness and feasibility check is carried out and if the result is positive it is sent to the process accepted order activity, in other case it is sent to the process rejected order activity.
- **Special products (out of catalogue):** In case the project has special products is needed to be sent to the calculate special case activity with the information concerning with the special items.

C. Activity Controls:

- **Accepted credit:** Output from A42. It allows the continuation of the order process.

D. Activity Mechanism:

- **Manufacturer's technical department:** Technician in the technical office or people from the development department capable of evaluating the projects technically.

D.1.5.4 Node A44. Process rejected order

When a project has technical or credit irregularities is sent to this activity.

A. Activity Inputs:

- **Rejected order form:** Output from A42

- **Rejected technical project:** Output of A43

B. Activity Outputs:

- **Manufacturer's notification:** The process rejected order activity produce a report for the Retailer to cancel the order or to wait for reply actions.

C. Activity Controls:

- **Order filter policy:** See page 13

D. Activity Mechanism:

- **Manufacturer's commercial department:** See page 13

D.1.5.5 Node A45. Calculate special case

When a project has special products the Retailer is not able to calculate the final budget or in all the cases it needs reconfirmation by the manufacturer.

The budget and delivery date are sent back to the retailer.

A. Activity Inputs:

- **Special products (out of catalogue):** Output from A43

- **Special case conditions acceptance:** When there is a special project the budget and delivery date are defined by the manufacturer and have to be accepted by the Retailer.

B. Activity Outputs:

- **Special case conditions:** Budget and delivery date for the special project are sent back to the Retailer waiting for acceptance.

C. Activity Controls:

- **Manufacturer's rule:** Rules defined for the special cases, increments over the normal price in case of cuts, etc.

D. Activity Mechanism:

- **Manufacturer's technical department:** See page 14

D.1.5.6 Node 46. Process accepted order

Both a standard project and a special one are treated in the same way once they have been accepted. It begins internal operation and the information flows to other department, Production, Logistics, Planning, etc.

A. Activity Inputs:

- **Special products (out of catalogue):** Output from A43
- **Standard products:** Output from A43

B. Activity Outputs:

- **Order information to production:** See page 8.
- **Manufacturer's notification:** See page 15

C. Activity Controls:

- **Special case conditions:** Output from A45

D. Activity Mechanism:

- **Manufacturer's commercial department:** See page 13

E Application reference model

(informative)

CONTENTS

E.1 Model Overview

The model consists of several schemas as shown in Figure E. 1.

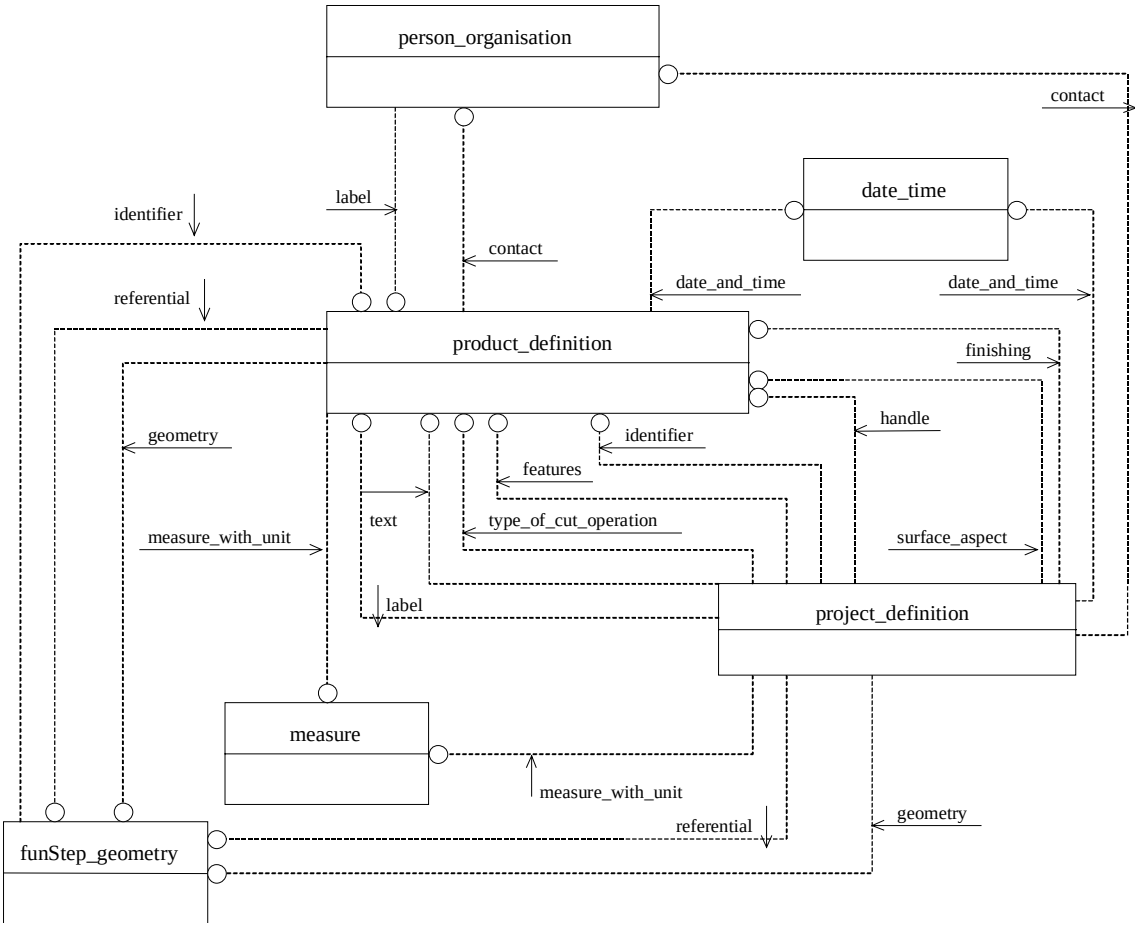


Figure E. 1 Complete schema-level model for the funStep project.

The schema product_definition is the primary schema. It references items from the schemata person_organization, date_time, measure and funstep_geometry.
The schema product_definition allows the representation of the manufacturers' product libraries including graphic and non-graphic information.

Another important schema is the project_definition. It references items from the schemata product_definition, date_time, person_organisation, measure and funstep_geometry. This schema allows the representation of furniture orders from commerce to manufacturers including needed information about the space to be furnished.

The schema funstep_geometry allows the geometric representation of the furniture product libraries.

E.2 PRODUCT_DEFINITION SCHEMA

This schema is the primary one in the model and is principally concerned with the definition of the products that the furniture manufacturers offer in their catalogues (the product libraries in an electronic format).

This schema contains supporting definitions for the project_definition schema. It imports definitions from the person_organization, date_time, measure and funstep_geometry.

The following picture represents an example of a simple piece of furniture to be described with the funStep model presented in this document:

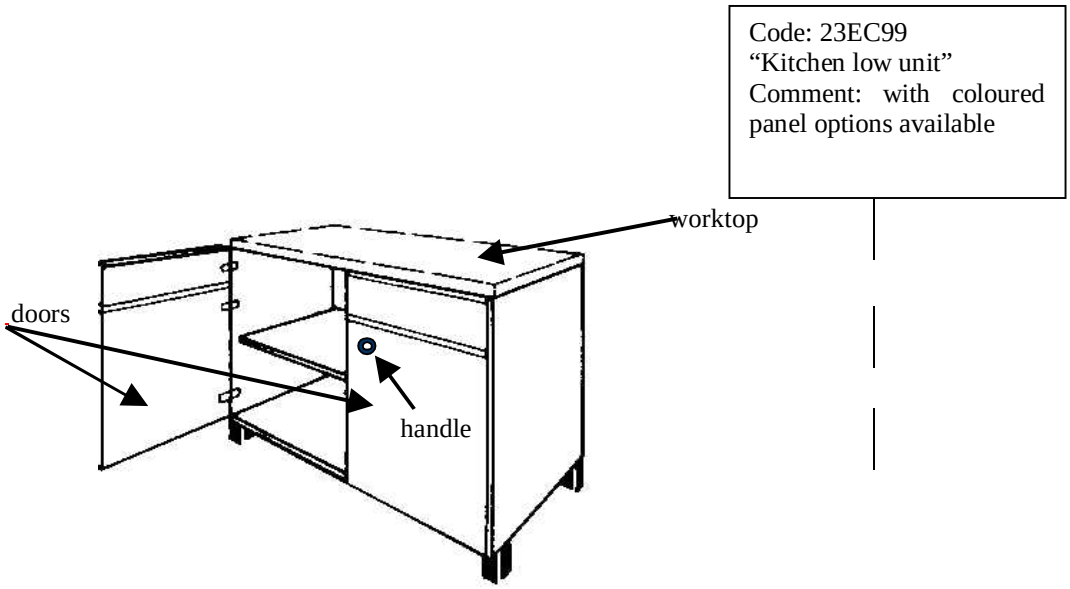


Figure E. 2 Kitchen low unit with two doors

This is a simple piece of furniture a kitchen low unit that is composed by two doors, a corpus and interior shelf to keep some goods in and handles to allow opening the doors. The finishing of the door is plain. This furniture is complemented with a part where is possible to work something, the worktop.

E.2.1 Type definitions

E.2.1.1 Type TYPE_OF_MEASURE

This type indicates how a product is sold; by linear meter, square meter or with a price by unitary item. In Figure E. 3, there is a example of each case. Furniture in general is sold by unitary price, for example this bed is 500 Euro. Shelves or desktops are usually sold by lineal meter and kitchen worktop that would be dependent of the width and length is sold by square meter.

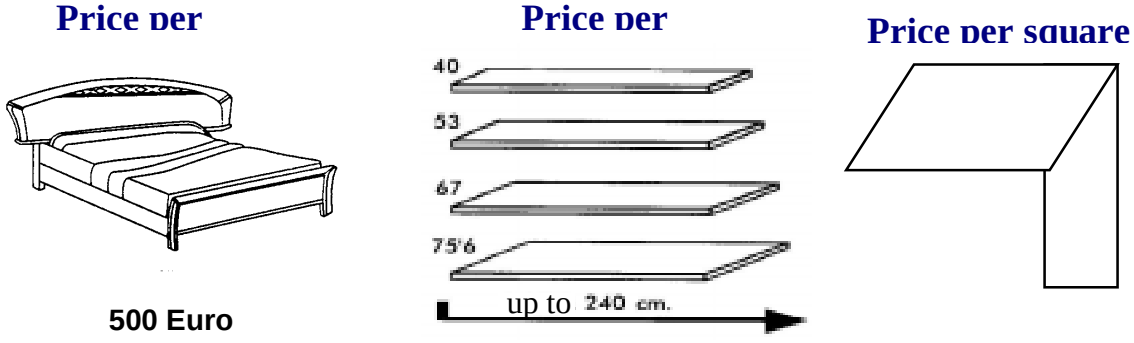


Figure E. 3 Products sold by unitary price, linear and square meters

In the example of shelves of Figure E. 3, the way to calculate the price of one shelf is taking the value to be multiplied in dollars depending on the depth and multiplying it by the desired width.

Depth	Id	Dollars
40 cm	500430	10 x linear meter
53 cm	500431	12 x linear meter
67 cm	500433	13 x linear meter
75,6 cm	500435	15 x linear meter

EXPRESS specification:

```
*)
TYPE type_of_measure = ENUMERATION OF (unitary, linear_meter, square_meter);
 END_TYPE;
(*
```

E.2.1.2 Type KIND_OF_CURRENCY

This type indicates the current currency used in the exchange, national currency; marks, escudos, pesetas, dollars, etc. or the value in points assigned to products.
Some manufacturers or providers distribute the catalogues without specifying the price in currency for each item, instead of that they assign a values in points, the same for all their clients and after inform them one by one of the value of the "point". With this mechanism they can update the price each season only changing the value of the point.

EXPRESS specification:

```
*)
TYPE kind_of_currency = ENUMERATION OF (value_in_points, PTE, PTA, DME, ESC,
Euro, US Dollars);
 END_TYPE;
(*
```

E.2.1.3 Type TYPE_OF_PRICE_FACTOR

If a product became a special product because it takes a modification, then it takes a price increase. The increase can be a fixed amount or a percentage of the actual price.

EXPRESS specification:

```
*)
TYPE type_of_price_factor = ENUMERATION OF ( fixed_price, percentage  );
 END_TYPE;
(*
```

E.2.1.4 Type KIND_OF_PRODUCT

This type indicates the type of product each item in the catalogue is. It is an enumeration of several types of simple products, which can be used in a catalogue or project. In the example of Figure E. 3, from left to right there are a "bed", some "shelves" and a "kitchen worktop". The bed is a composite product while the shelves and worktop are simple.

EXPRESS specification:

```
*)
TYPE kind_of_product = ENUMERATION OF (bed, accessory, appliance, corpus, module_base, seat_furniture, sink, table, worktop, shelf, door, drawer);
 END_TYPE;
(*
```

E.2.1.5 Type LABEL

It is the term by which something may be referred to. It is a string. In the example of the Figure E. 2, the string “kitchen low unit” represents the label.

EXPRESS specification:

```
*)
TYPE label = STRING;
END_TYPE;
(*
```

E.2.1.6 Type IDENTIFIER

It is an alphanumeric string that allows an individual thing to be identified. In the example of the Figure E. 2, the label is represented by the string “23EC99”

EXPRESS specification:

```
*)
TYPE identifier = STRING;
END_TYPE;
(*
```

E.2.1.7 Type TEXT

It is an alphanumeric string of characters, which is intended to be read and understood by a human being. In the example of the Figure E. 2, the label is represented by the string “With coloured panel options available”

EXPRESS specification:

```
*)
TYPE text = STRING;
END_TYPE;
(*
```

E.2.1.8 Type TYPE_OF_CUT_OPERATION

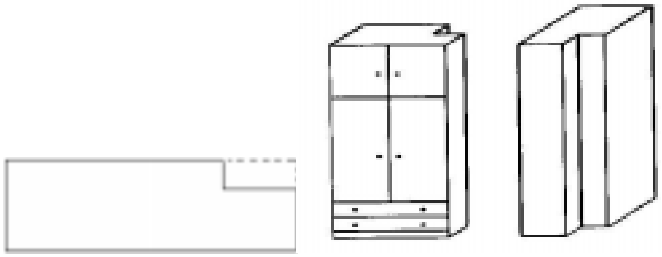
This type indicates the type of cutting operations that are allowed on the products, when some of these operations are performed, the products became “special products”.

EXPRESS specification:

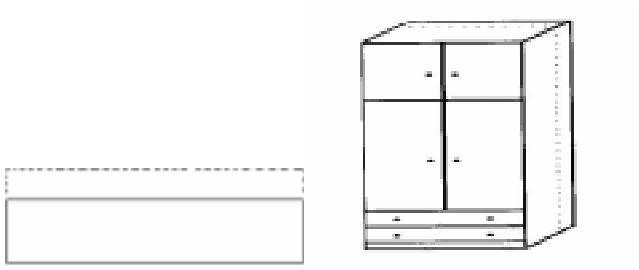
```
*)
TYPE type_of_cut_operation = ENUMERATION OF ( column, beam, depth, height, width );
END_TYPE;
(*
```

The following image represents some examples of usual cut operations.

- Column cut , this cupboard has been cut to adjust it to a column in the room.

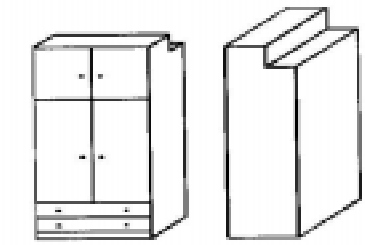


- Depth cut.



The available depth in the place to put the product is shorter than the rest of the wall of the kitchen, and then the product is cut to fit.

- Beam cut , this cupboard has been cut to adjust it to a beam in the room.



E.2.2 Entity definition

E.2.2.1 Entity FURNITURE_SUPPLIER

A furniture_supplier is the one who manufactures or distributes furniture pieces.

EXPRESS specification:

```
*)
ENTITY furniture_supplier;
  addresses : SET [1:?] OF contact;
```

```
  offered_catalogues : SET [1:?] OF catalogue;
  vat_number : identifier;
  commercial_name : label;
  fiscal_name : label;
 END_ENTITY;

(*
```

Attribute definitions:

vat_number: a number or alphanumeric string that identifies the furniture supplier, for example "G46261590".

commercial_name: text that relates the known commercial name of a furniture_supplier, for example, "Muebles López".

fiscal_name: a string that identifies the furniture, for instance, "Jose Antonio López S.A.".

addresses: a set of addresses where the furniture supplier company and/or retailers maybe contacted, for example, "25, Oxford street, Cornfield. U.K."

offered_catalogues: the set of catalogues that a furniture supplier provides.

Figure E. 4 shows the EXPRESS-G specification of the furniture_supplier entity.

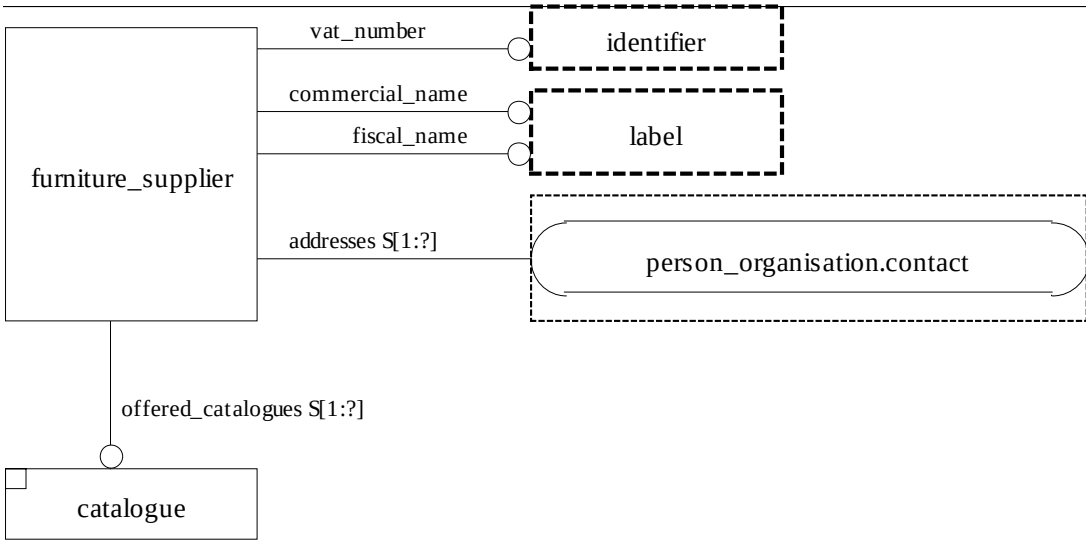


Figure E. 4 Entity-level of the entity furniture_supplier.

As an example, the furniture supplier only has one catalogue with one program, which only has one product, the "kitchen worktop".

E.2.2.2 Entity CATALOGUE

A catalogue is a collection of products, usually under a product line; kitchen, bathroom, youth bedroom, double bedroom, office, upholstery, etc. This classification is useful to identify common characteristics (as functionality, shape or product configuration).
For any item in the catalogue there is some information about price, height, width and depth, available finishing, a graph that shows its shape, configuration, etc.

A catalogue can have a set of programs. For instance, the furniture_supplier Ros-1 has a unique Catalogue called ELEMENTS.
As mentioned above, the catalogue only has one product, with the correct attributes applied to it.

EXPRESS specification:

```
*)
ENTITY catalogue;
  programs : SET [1:?] OF program;
  name : label;
  description : text;
  valid_from : date_and_time;
 END_ENTITY;
 (*
```

Attribute definitions:

name: the catalogue's name.

description: text that relates the nature of the catalogue.

valid_from: the date from where the catalogue is valid. The new catalogue replaces the previous one.

programs: the set of programs that constitutes the catalogue, if any. For example, Paris, Madrid, Lisbon.

The Figure E. 5 shows the EXPRESS-G specification of the catalogue entity.

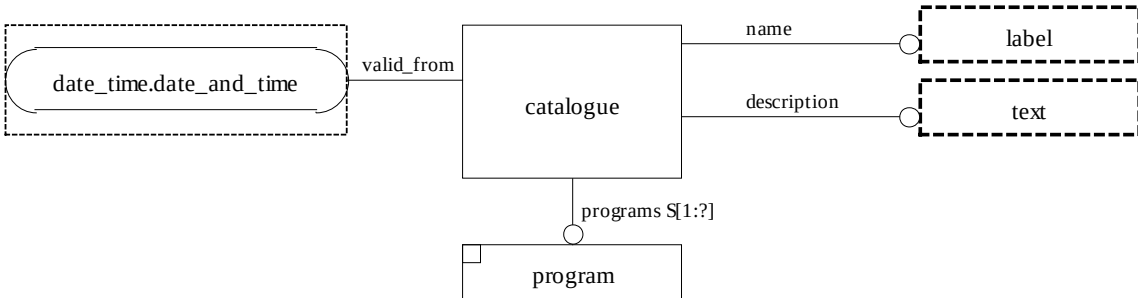


Figure E. 5 Entity-level of the entity catalogue.

E.2.2.3 Entity PROGRAM

A program groups a finite set of program products (up/down units, wardrobes, shelves, bedside tables, buffets, chests of drawers, beds, seat furniture, tables and module complements or accessories, etc.) with some similar attributes allowed in that program; shapes, base colours/materials, type of finishing, handles, etc.

EXPRESS Specification

```
*)
ENTITY program;
  products : SET [1:?] OF program_product;
  attributes : SET [1:?] OF attributes;
  price_group : identifier;
```

END_ENTITY;
(*

products: a set of products with the attributes of this program.

attributes : the feature definitions allowed for this program in the catalogue.

price_group: an identifier of the price group that the program belongs to. In the case of several (many) programs, it is better understood to display the programs only by the price group.

Figure E. 6 shows the EXPRESS-G specification for the entity program_product.

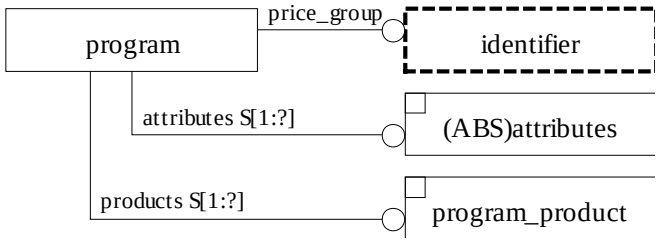


Figure E. 6 Entity-level of the entity program.

The attributes applied to the *program_product* "kitchen worktop" in the example of the Figure E. 2 are described in the ENTITY attributes below in this document. The price group identifier for this product is "G2".

E.2.2.4 Entity PROGRAM_PRODUCT

The program_product entity has a specific function in the model, it allows to have catalogue products with different attributes based on the attributes of the program.
Each product in a program has a basic price associated according to its size measure (height, width and depth) and its components (doors, drawers, shelves, etc.); it also has rules for calculating the price of the product.

EXPRESS Specification

*)
ENTITY program_product;
  price : price;
  product : catalogue_product;
  id : identifier;
 END_ENTITY;
(*

Figure E. 7 shows the EXPRESS-G specification for the entity program_product.

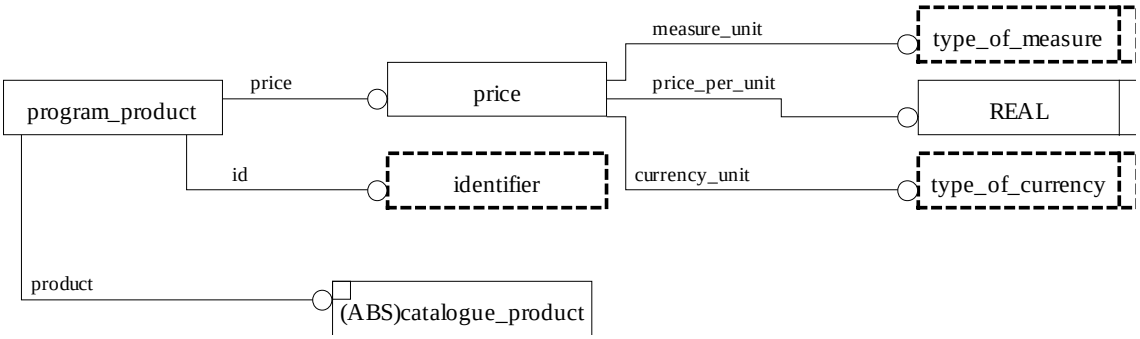


Figure E. 7 Entity-level of the entity program_product.

Attribute definitions:

price: the price of the product in the program.

id : the product identifier in the program.

product: the product without any specific feature on it, just it's geometry definition.

From the Figure E. 2, the program product "kitchen worktop" is identified by "KW0599", and the price is defined below in the next ENTITY price.

E.2.2.5 Entity PRICE

The price is a quantity (points or currency) assigned to each selling article or catalogue_product. The final price of a product depends on the product and the program selected.

EXPRESS Specification:

```
*)
ENTITY price;
  measure_unit : type_of_measure;
  price_per_unit : REAL;
  currency_unit : type_of_currency;
END_ENTITY;
(*
```

Figure E. 7 shows the EXPRESS-G specification for the entity price.

Attribute definitions:

measure_unit: the type of the price value in points or currency of the linear, square meter or cubic meter.

price_per_unit: the value of the price according to the type of pricing specified in **unit_for_pricing.**

currency_unit: the unit system for the price value, for example: Euro, US dollar, pesetas, marks, escudos, etc.

For the example in Figure E. 2, the final price is presented in *Euro* (the currency unit for pricing), the measure unit for pricing is *linear meter* of product, and the price per unit is *249,40 Ers*

E.2.2.6 Entity CATALOGUE_PRODUCT

A catalogue_product is the identification and description of an article manufactured by a furniture manufacturer. A catalogue_product constitutes an article for sale with a unique identifier, description, name and short name.
The catalogue_product also describes in a general way the variations allowed, which are the cut operations allowed.
EXPRESS Specification

```
*)
ENTITY catalogue_product
  kind_of_product : kind_of_product;
  size : boundary_box;
  required_space : OPTIONAL boundary_box;
  operations : SET [0:?] OF measure_suit_operation;
  code : identifier;
  name : label;
  position : referential;
  inhouse_id : OPTIONAL identifier;
  description : text;
  short_name : label;

UNIQUE
  un1: id;
END_ENTITY;
(*
```

Figure E. 8 shows the EXPRESS-G specification for the entity catalogue_product.

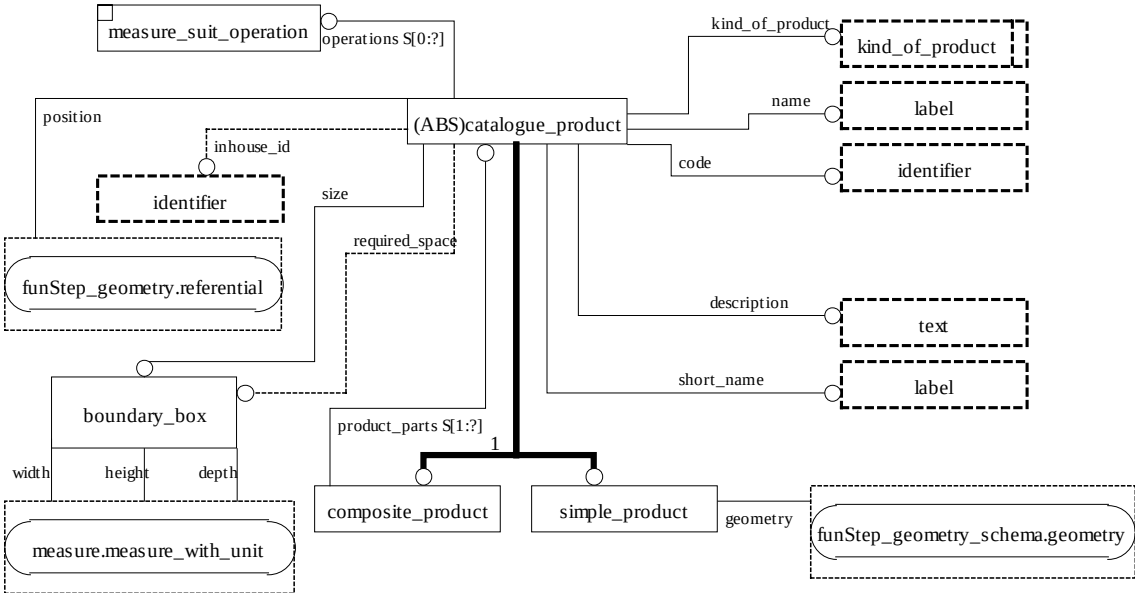


Figure E. 8 Entity-level of the entities catalogue_product, composite_product and simple_product.

Attribute definitions:

kind_of_product: indicates the kind of product defined by this entity

size: the 3D box that contains the entire product inside

required_space: the necessary space for the product work correctly

operations: a set of special operations allowed to be performed in the product, for example, to accommodate a product in a corner of a room.

code: the identifier of the product in the catalogue. It must be unique.

name : the complete name of the product

position : the referential position in relation to the space where the product is put, all the product parts are defined relative to this referential.

inhouse_id : the identifier just for inside the manufacturing company

description : text that relates the nature of the catalogue_product. For example, Low unit with four drawers.

short_name: an abbreviation of the description. For example, LU4D.

size : the physical quantities for height, width and depth are length as defined in ISO 31.

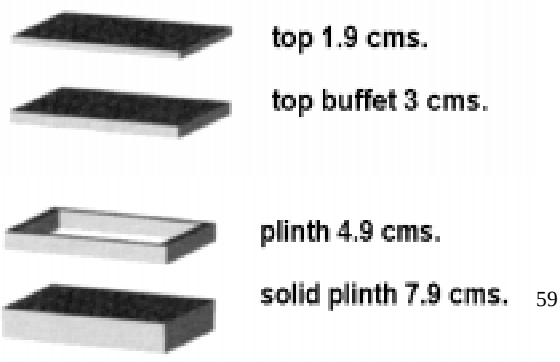
Formal Propositions:

un1: every catalogue_product identification shall be unique.

In the example of the Figure E. 2, the catalogue_product is a composite of simple products: an worktop, two doors, and a corpus.
The product has two identifiers, one only for manufacturer's use, which is "54KW82" and another to identify the product between the manufacturer, retailers, and customers, "KTWKT0199". The product dimensions (boundary box) are: width 1890mm; height 740mm; depth 590mm. The required space is: width 1890mm; height 740mm; depth 1440mm; the depth is different. In order to work correctly the product "kitchen worktop" "needs" some space to enable the doors open.
The product has a name: "kitchen worktop", a short name "KW2D", a description "place where to cut vegetables", and the kind of product is "worktop".
Only to use in order to display the product for customer visualization, there is a point from where the all parts of the product are geometrical defined, that is the referential; X 230mm; Y 340mm; Z 120mm, related to the origin of the representation space.

E.2.2.7 Entity SIMPLE_PRODUCT

Defines a simple product, which only specifies the geometry of the product. This can be a worktop, drawer, door, etc..



EXPRESS Specification:

```
*)
ENTITY simple_product
  SUBTYPE OF (  catalogue_product  );
```

```
  geometry : geometry;
 END_ENTITY;
(*
```

Attribute definitions:

geometry: the points and lines that define the geometry specification of all product surfaces, as specified in Part 42.

Figure E. 8 shows the EXPRESS-G specification for the entity simple_product.

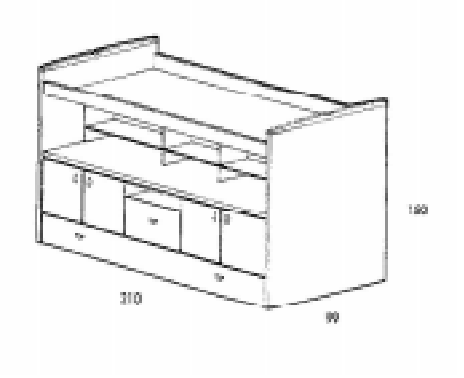
From the Figure E. 2, there are simple products that compose the final product: two doors, a corpus, and the worktop. Each of the simple products: worktop, corpus, and doors; are defined only by its geometric representation: lines and points.

E.2.2.8 Entity COMPOSITE_PRODUCT

Defines a composite product, which is a set of two or more simple products or composite products.

EXPRESS Specification:

```
*)
ENTITY composite_product
  SUBTYPE OF ( catalogue_product );
  product_parts : SET [2:?] OF catalogue_product;
 END_ENTITY;
(*
```



Attribute definitions:

product_parts: a set of the parts that together compose the all product.

Figure E. 8 shows the EXPRESS-G specification for the entity composite_product.

In this example, the composite product “compack bed” is defined as a set of simple products: door_units, lateral_supports, matress, pull-out bed, handrails, etc.

E.2.2.9 Entity BOUNDARY_BOX

Defines a 3D volume box.

EXPRESS Specification:

```
*)
ENTITY boundary_box;
  width : measure_with_unit;
  height : measure_with_unit;
  depth : measure_with_unit;
 END_ENTITY;
(*
```

Attribute definitions:

width : the width of the 3D volume box.
height : the height of the 3D volume box.
depth : the depth of the 3D volume box.

Figure E. 8 shows the EXPRESS-G specification for the entity composite_product.

From the example of Figure E. 2, the boundary box of the product "kitchen worktop" enable to define the required space for the product to work correctly, and in this case the required dimensions for this product attribute are: width 1890mm; height 740mm; depth 1440mm. The depth measure is bigger in order to the product "kitchen worktop" work correctly, it "needs" some space to enable the doors open.

E.2.2.10 Entity MEASURE_SUIT_OPERATION

This entity defines the operation allowed to be carry out on a product in a particular program. The types under scope are; width cutting, height cutting, depth cutting, column cutting and beam cutting.
When a catalogue_product suffers a measure_suit_operation it becomes a special_product.
Each operation has an associated factor to be applied for calculation of the price of the special_product.

EXPRESS Specification:

```
*)
ENTITY measure_suit_operation;
  price_factor : price_factor;
  comments : text;
  drawing : BOOLEAN;
  x_cut_max : OPTIONAL measure_with_unit;
  y_cut_max : OPTIONAL measure_with_unit;
  z_cut_max : OPTIONAL measure_with_unit;
  alowed_operation : type_of_cut_operation;
 END_ENTITY;
(*
```

Figure E. 9 shows the EXPRESS-G specification for the entity measure_suit_operation.

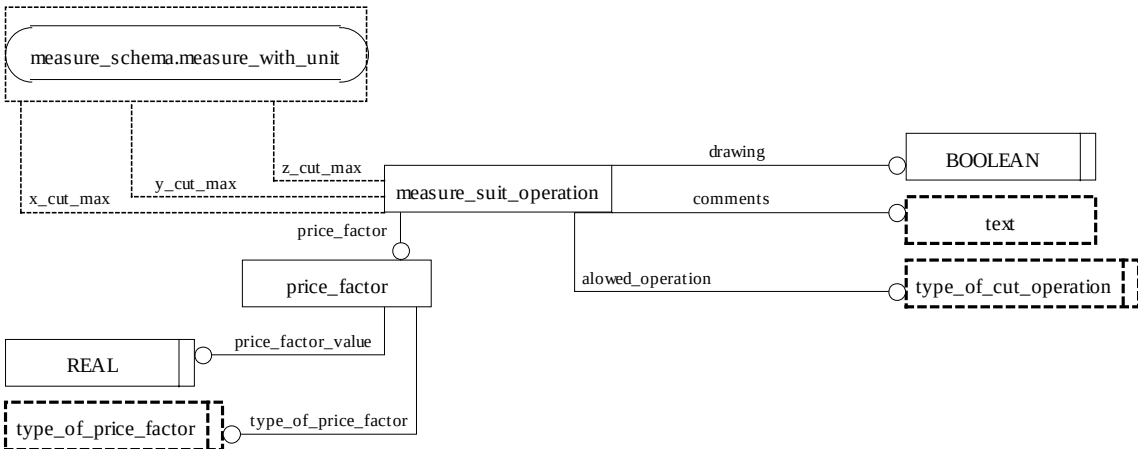


Figure E. 9 Entity level of the entity measure_suit_operation and price_factor

Attribute definitions:

price_factor : indicates how much (value) the price will increase and the type of increase, for example, percentage.
comments : text information about the operations performed in the object.
drawing : it is a flag that indicates if there is a drawing explaining the cut operation required.
x_cut_max : maximum measure cut in XX's (width)
y_cut_max : maximum measure cut in YY's (depth)
z_cut_max : maximum measure cut in ZZ's (height)
alowed_operation : the type of cut operation to be performed in the product.

The example of the Figure E. 2, the maximum cut measures are: X 100mm, Y 50mm, Z 150mm, and the cut operation allowed for the product "kitchen worktop" is depth. There no drawing for complementing the cut operation understanding, and the price factor for the modification is an increment of 25% in the base price of the product.
The comments are related with the cut operation, for example: "cut the material of the worktop in slow speed".

E.2.2.11 Entity ATTRIBUTES

An abstract entity of a group of distinctive entities, which represent the aspect characteristics of the program products: base material/colour (melamine, veneer, wood, glass, plastic, etc.), secondary colour, type of handle, etc.

EXPRESS Specification:

```
*)
ENTITY attributes
        ABSTRACT SUPERTYPE OF (ONE OF(base_colour_attributes,
complementary_colour_attributes, fabrics_attributes, handle_attributes, finishing_attributes))
END_ENTITY;
(*
```

Figure E. 10 shows the EXPRESS-G specification for the entity attributes and it's subtypes.

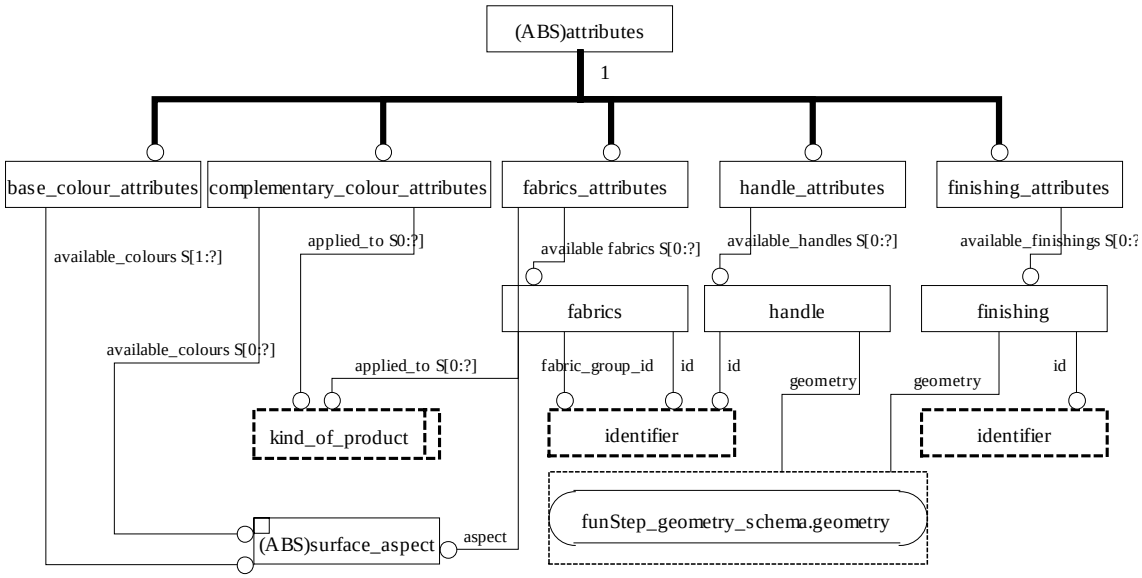


Figure E. 10 Entity level of the entity attributes and its subtypes

For the example of the Figure E. 2, the possible attributes are: several colours, handles, and finishings. In this program there are not attributes of fabrics.

E.2.2.12 Entity BASE_COLOUR_ATTRIBUTES

The colours that are applicable to all parts of the product.

EXPRESS Specification:

```
*)
ENTITY base_colour_attributes
  SUBTYPE OF (   attributes  );
  available_colours : SET [1:?] OF surface_aspect;
 END_ENTITY;
(*
```

Figure E. 10 shows the EXPRESS-G specification for the base_colour_attributes.

Attribute definitions:

available_colours : a set of available base colours for this program

For the example of the Figure E. 2, the base colours are:

pine, oak

E.2.2.13 Entity COMPLEMENTARY_COLOUR_ATTRIBUTES

The colours that are applicable to only to a specific set of parts of the product.

EXPRESS Specification:

```
*)
ENTITY complementary_colour_attributes
  SUBTYPE OF ( attributes );
  available_colours : SET [0:?] OF surface_aspect;
  applied_to : SET OF kind_of_product;
 END_ENTITY;
(*
```

Figure E. 10 shows the EXPRESS-G specification for the complementary_colour_attributes.

Attribute definitions:

available_colours : a set of available complementary colours for this program

applied_to : the set of parts to which the complementary colours are applied

For the example of the Figure E. 2, the complementary colours are:

white, grey, black

which are applied to the part(s):

door and handle

E.2.2.14 Entity FABRICS_ATTRIBUTES

The fabrics that can be applied on the product. It also specifies what parts can take fabrics.

EXPRESS Specification:

```
*)
ENTITY fabrics_attributes
  SUBTYPE OF (   attributes  );
  applied_to : SET [0:?] OF kind_of_product;
  available : SET [0:?] OF type_of_fabrics;
 END_ENTITY;
(*
```

Figure E. 10 shows the EXPRESS-G specification for the fabrics_attributes.

Attribute definitions:

available_fabrics : a set of available fabrics for this program

applied_to : the set of parts to which the fabrics are applied

E.2.2.15 Entity FABRICS

One of the fabrics that can be applied on the product.

EXPRESS Specification:

```
*)
ENTITY fabrics;
  id : identifier;
  fabric_group_id: identifier;
  aspect : surface_aspect;
 END_ENTITY;
(*
```

Figure E. 10 shows the EXPRESS-G specification for the fabrics.

Attribute definitions:

id : the fabric's identifier.

aspect : the material or colour of the fabrics

fabric_group_id: the identifier of each set of fabrics grouped to allow sets of price to be applied depending, among others, on fabric quality criteria.

E.2.2.16 Entity HANDLE_ATTRIBUTES

A small piece of any material being part of a drawer or door by which they may be opened. They can be have different materials (wood, metal, plastic, etc.) and have different colours.

EXPRESS Specification:

```
*)
ENTITY handle_attributes
  SUBTYPE OF (   attributes  );
  available_handles : SET [0:?] OF type_of_handle;
 END_ENTITY;
(*
```

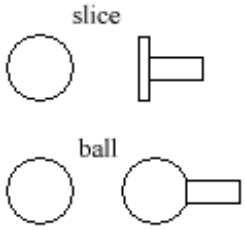
Figure E. 10 shows the EXPRESS-G specification for the handle_attributes.

Attribute definitions:

available_handles : a set of available handles for this program

For the example of the Figure E. 2, the handles applicable are:

slice, ball; (below is an images that demonstrates the two types of handles)



E.2.2.17 Entity HANDLE

One handle that can be applied on the product.

EXPRESS Specification:

```
*)
ENTITY type_of_handle;
  geometry : geometry;
  id : identifier;
 END_ENTITY;
(*
```

Figure E. 10 shows the EXPRESS-G specification for the handle.

Attribute definitions:

id : the handle identifier.

geometry: the points and lines that define the geometric representation of the handle

For the example of the Figure E. 2, the type_of_handle, which has the identifier “SC1256H99” and a geometric representation define each kind of handle: points and lines.

E.2.2.18 Entity FINISHING_ATTRIBUTES

The cornices in the front parts of the products.

EXPRESS Specification:

```
*)
ENTITY finishing_attributes
  SUBTYPE OF (
   attributes
  );
  available_finishings : SET [0:?] OF type_of_finishing;
 END_ENTITY;
(*
```

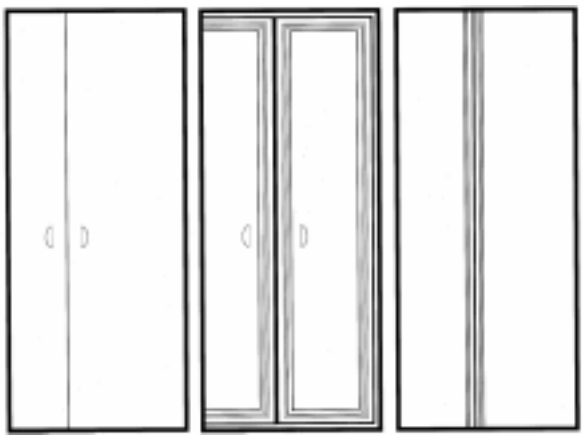
Figure E. 10 shows the EXPRESS-G specification for the finishing_attributes.

Attribute definitions:

available_finishing : a set of available finishing for this program

For the example of the Figure E. 2, the finishing applicable are:

plain, frame, moulding; (the example below presents this three types of finishings)



Plain **Frame** **Moulding**

E.2.2.19 Entity FINISHING

Kind of cornice in the front parts of the products.

EXPRESS Specification:

```
*)
ENTITY finishing;
  geometry : geometry;
  id : identifier;
 END_ENTITY;
(*
```

Figure E. 10 shows the EXPRESS-G specification for the finishing.

Attribute definitions:

id : the finishing identifier.

geometry: the points and lines that define the geometric representation of the finishing

For the example of the Figure E. 2, each kind of finishing is defined by the finishing, which has the identifier “SMT3256F99” and a geometric representation: points and lines.

E.2.2.20 Entity SURFACE_ASPECT

It is the appearance of any part of a product referring to its colour or material.

EXPRESS Specification:

```
*)
ENTITY surface_aspect
        ABSTRACT SUPERTYPE OF (ONEOF(material, colour) );
        id: identifier;
        name: label;
        description: OPTIONAL text;
END_ENTITY;
(*
```

Figure E. 11 shows the EXPRESS-G specification for the entity surface_aspect and it’s subtypes.

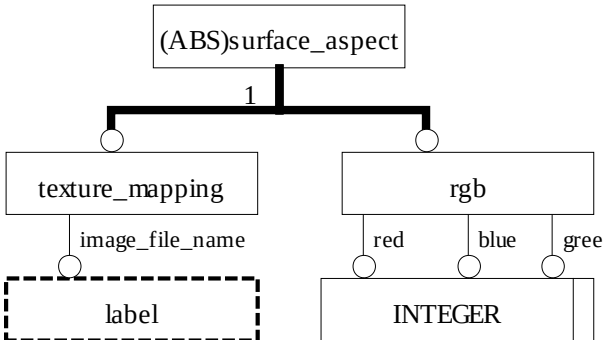


Figure E. 11 Entity-level of the entity surface_aspect and it’s subtypes.

Attribute definitions:

id: the identification of the surface aspect, for example, P002.

name: the word or group of words by which the surface aspect is referred to, for example: pine.

description: text that relates the nature of the surface aspect.

E.2.2.21 Entity TEXTURE_MAPPING

Substance or thing from which something is made of.

EXPRESS Specification:

```
*)
ENTITY texture_mapping
  SUBTYPE OF (
   surface_aspect
  );
  image_file_name : label;
 END_ENTITY;
(*
```

Figure E. 11 shows the EXPRESS-G specification for the entity texture_mapping.

Attribute definitions:

image_file_name: the name of the file which contains the representation of the texture mapping, for example: “pine.jpg”. The format JPEG must be used.

In the example of the Figure E. 2, the surfaces that are defined by a texture mapping use this entity with the identifier, “TEX1874”; with the name “PINE”, and some text for clarify the texture mapping: “pine to apply on the doors”, finally, the name of the image that represents the pine texture mapping: “pine_image.jpg”.

E.2.2.22 Entity RGB

A colour_rgb defines a colour by specifying the intensity of red, green and blue. It contains a colour definition, which refers directly to a specific colour space.

A colour defines a basic appearance property of an element with respect to the light reflected by it.

EXPRESS Specification:

```
*)
ENTITY rgb
SUBTYPE OF (
surface_aspect
);
        red : INTEGER;
        green : INTEGER;
        blue : INTEGER;
WHERE
```

```
WR1 : {0<=red<=255};
WR2 : {0<=green<=255};
WR3 : {0<=blue<=255};
END_ENTITY;
(*
```

Figure E. 11 shows the EXPRESS-G specification for the entity rgb.

Attribute definitions:

red: the intensity of the red colour component.

green: the intensity of the green colour component.

blue: the intensity of the blue colour component.

Formal propositions:

wr1: the intensity of the red colour component shall be between 0 and 255.
wr2: the intensity of the green colour component shall be between 0 and 255.
wr3: the intensity of the blue colour component shall be between 0 and 255.

In the example of the Figure E. 2, the colour *gray* is defined by the three-colour components RGB: Red 106; Green 106; Blue 106.

E.3 FUNSTEP_GEOMETRY SCHEMA

This schema concerns with the explicit representation of the shape or geometric form of a product described in the product_definition schema.

This schema contains definitions for the primary product_definition and project_definition schemas.

Figure E. 12 shows the EXPRESS-G specification for the funStep geometry schema.

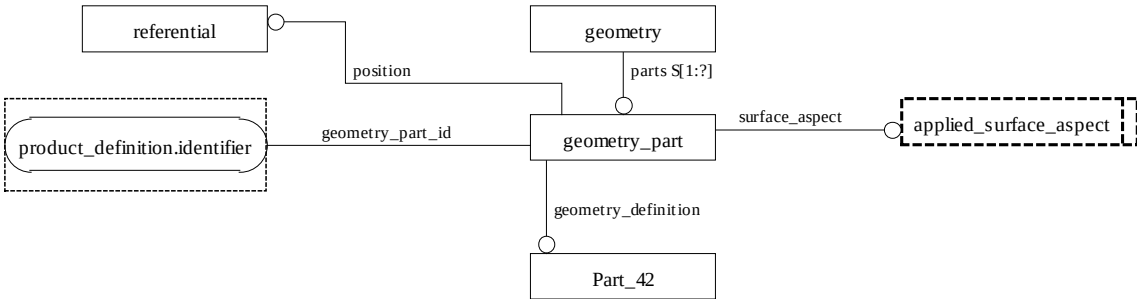


Figure E. 12 Entity-level of the entity geometry and it's subtypes.

E.3.1 Type definitions

E.3.1.1 Type APPLIED_SURFACE_ASPECT

The type of surface aspect to apply on each geometric product part

EXPRESS specification:

```
*)
TYPE applied_surface_aspect = ENUMERATION OF ( base_colour, complementary_colour, fabric, base_and_complementary_colours, base_colour_and_fabric, complementary_colour_and_fabric, base_and_complementary_colours_and_fabric );
 END_TYPE;
(*
```

For the example in the Figure E. 2, the aspect to apply on the doors, for example, is base colour and complementary colours “base_and_complementary_colours”; to the worktop only apply the base colours, in this case the value is “base_colour”.

E.3.2 Entity definition

E.3.2.1 Entity GEOMETRY

This entity allows the geometric representation of each product defined in the furniture supplier’s catalogue. Each product’s geometry it is represented by points and lines.

EXPRESS Specification:

```
*)
ENTITY geometry;
  parts : SET [1:?] OF geometry_part;
 END_ENTITY;
(*
```

Attribute definitions:

parts: a set of geometric parts defined by lines and points

The example “kitchen worktop” in the Figure E. 2, the worktop is divided in six surfaces (top, bottom, back, front, left side, right side), each surface is a *geometry_part*.

E.3.2.2 Entity GEOMETRY_PART

The parts in which all the catalogue products are divided to define their geometric representation. Each part is a surface.

EXPRESS Specification:

```
*)
ENTITY geometry_part;
  position : referential;
  geometry_definition : Part_42;
  surface_aspect : applied_surface_aspect;
  geometry_part_id : identifier;
 END_ENTITY;
(*
```

Figure E. 12 shows the EXPRESS-G specification for the entity geometry_part.

Attribute definitions:

position: the location of the geometric part relative to the complete product

geometry_definition: the definition of the curves and/or points that specify the part.

surface_aspect: the colour or material that represents the aspect of the surface.

geometry_part_id: the part identifier.

In the example of the "kitchen worktop", the worktop part defined (*geometry_definition*) by lines and points, has a referential position related to the complete component, the aspect to apply on it is specified by the attribute *surface_aspect*, and is identified by "01GP23WT99"

E.3.2.3 Entity REFERENTIAL

Defines the position in 3D of an object relative to the reference co-ordinate system in question.

EXPRESS Specification:

```
*)
ENTITY referential;
END_ENTITY;
(*
```

In order to "move" the complete product "kitchen worktop" in Figure E. 2, only by changing it position, it can be defined it's relative position.

E.3.2.4 Entity PART_42

The representation of the points and lines to define the geometric product parts. This definition is from Part 42.

EXPRESS Specification:

```
*)

ENTITY Part_42;
END_ENTITY;
 (*
```

E.4 PERSON_ORGANIZATION SCHEMA

People and organisations are associated with product data to provide data concerning administrative structures and individuals that serve as points of contact or have particular responsibility in those structures.

E.4.1 Type definition

E.4.1.1 Type COMPANY_TYPE

The activity area of a company.

EXPRESS specification:

```
*)
TYPE company_type = ENUMERATION OF (furniture_manufacturer,
furniture_representative, retailer, big_retailer, private_customer,
furniture_supplier_raw_material, furniture_supplier_half_finished_products, supplier
representative );
 END_TYPE;
(*
```

For the example in the Figure E. 14 (in the project_definition schema), the company type of the "kitchen worktop" cabinet of the Figure E. 2, is: *furniture_manufacturer*.

E.4.2 Entity definition

E.4.2.1 Entity CONTACT

An address, telephones, numbers of facsimile, etc. of the place and people in organisations.

EXPRESS Specification:

```
*)
ENTITY contact;
  country : OPTIONAL label;
  email : OPTIONAL label;
  facsmile : OPTIONAL label;
  internal_extension : OPTIONAL label;
  postal_box : OPTIONAL label;
  region_code : OPTIONAL label;
  street : OPTIONAL label;
  number_in_street : OPTIONAL label;
  telephone : OPTIONAL label;
  telex : OPTIONAL label;
  town : OPTIONAL label;
  person_name : OPTIONAL label;
  company_range : company_type;
 END_ENTITY;
(*
```

Attribute definitions:

email: the electronic address at which electronic mail may be received.

telephone: the number at which telephone calls may be received.

town: the name of a town.

region_code: the code of a region.

country: the name of the country.

street: the name of the street.

number_in_ street: the number of a building in a street.

postal_box: the number of a postal box.

facsimilie: the number at which facsimiles may be received.

telex: the number at which telex messages may be received.

person_name: the name of the person to contact.

company_range: identifies the activity of the company. For example, furniture manufacturer, furniture supplier, private client, etc.

Figure E. 13 shows the EXPRESS-G specification for the entity address.

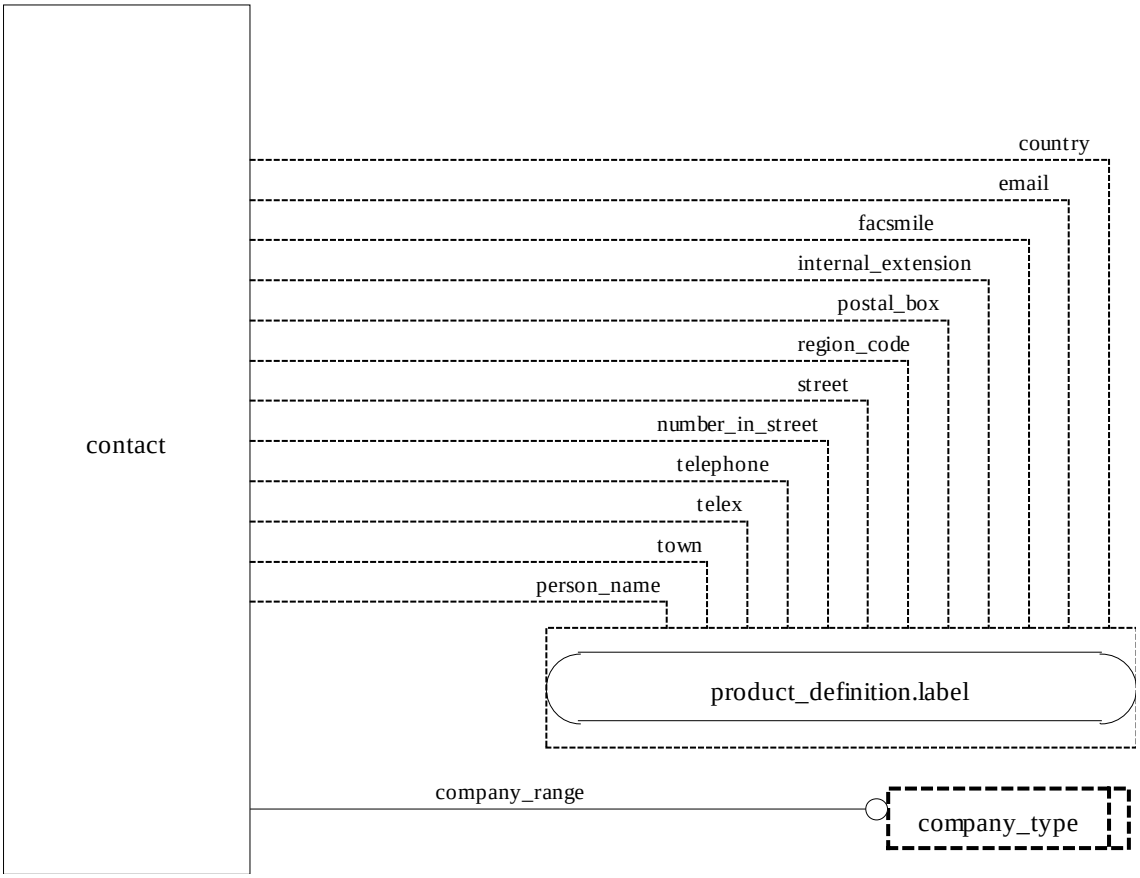


Figure E. 13 Entity-level of the entity contact.

For the exchange of the catalogue with the “kitchen worktop” in the Figure E. 2, it is necessary to identify the manufacturer, supplier or retailer. Below is an example of a manufacturer contact:

country : “Portugal”
email : “kitchen@manufacturer.pt”
facsmile : “+351 1 2941212”
internal_extension : “6601”
postal_box : “9812”
region_code : “23”
street : “furniture market”
number_in_street : “9854”
telephone : “+351 1 2943498”

telex : “”
town : “Almada”

- person_name : “Zeferino”
- company_range : “furniture_manufacturer”

E.5 DATE_TIME SCHEMA

This schema allows representations of dates, both calendar and ordinal, time of day, combinations of date and time of day, and periods of time to be defined.

E.5.1 Entity definitions

E.5.1.1 Entity DATE

E.6 MEASURE SCHEMA

This schema contains resource constructs that allow physical quantities to be described.

See ISO 10303-41 page 113 for the definition of types and entities.

E.7 PROJECT_DEFINITION SCHEMA

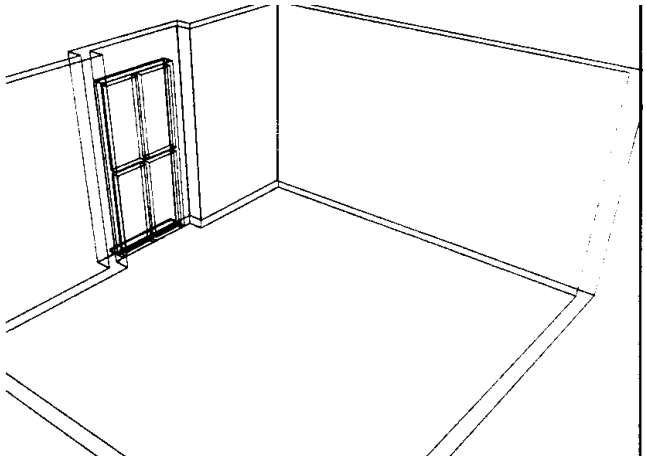
This schema is principally concerned with ordering of products using the product libraries in an electronic format supplied by the furniture manufacturers.

This schema imports definitions from the product_ definition, person_organization, date_time, and funStep_geometry schemata.

The steps needed to produce a furnishing project are presented in the following sequence of pictures:

1. Define the space (room):

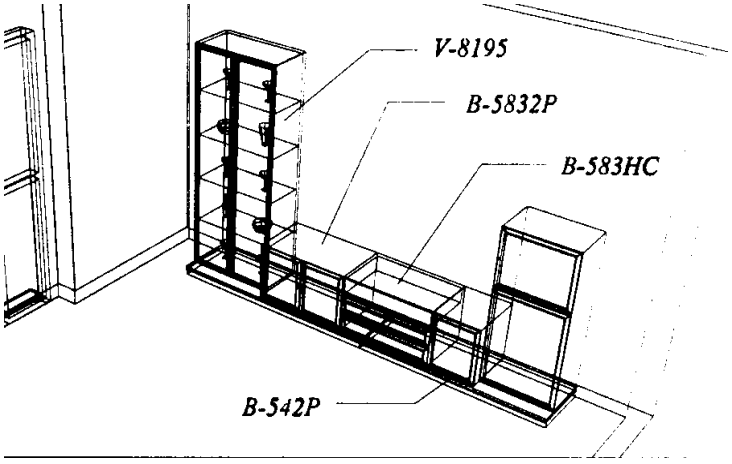
- **walls/floor/ceiling**
- **doors/windows**
- **housing/spur**
- **installation**
- **camera/light**



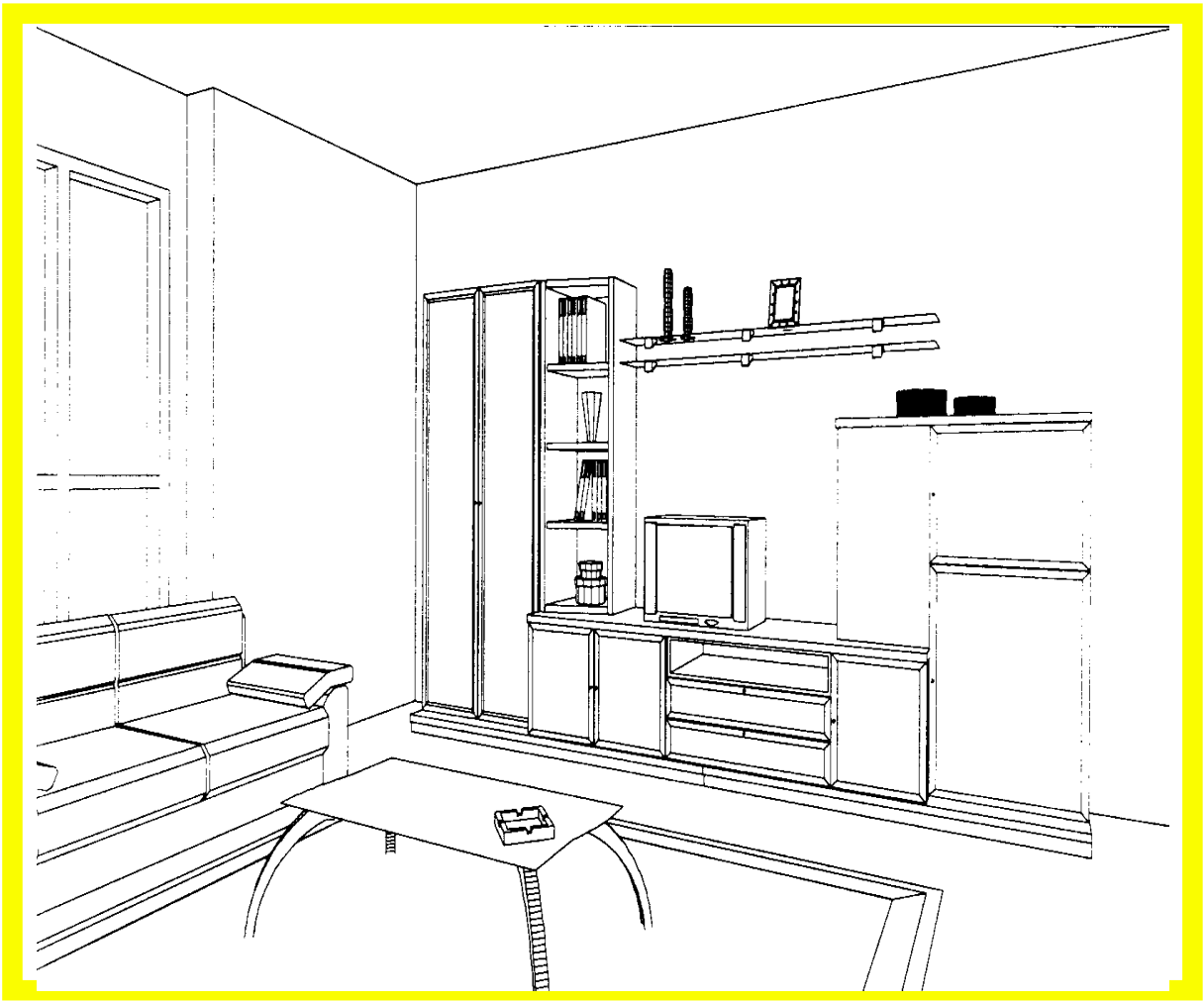
2. Position products

- **select catalogue**
- **select product**

- **position it**

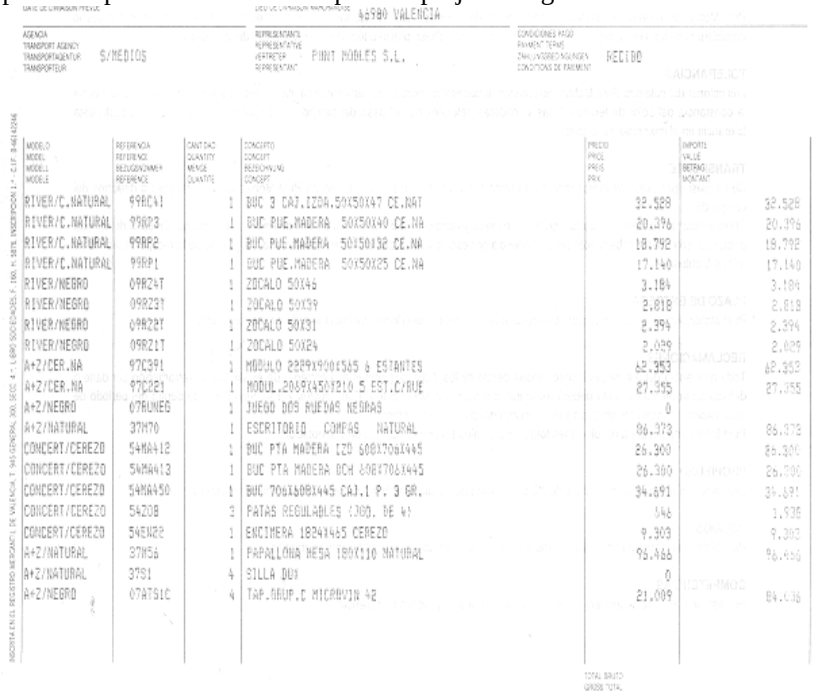


After two steps the project state is represented in the following picture



3. calculate budget

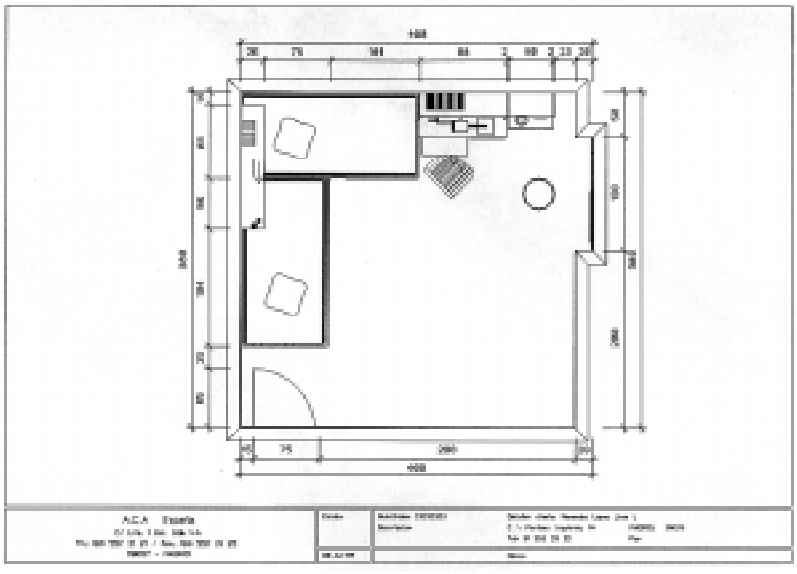
The following picture represents a short example of a project budget:



MODELO	REFERENCIA	CANTIDAD	CONCEPTO	PRECIO	IMPORTE
RIVER/C.NATURAL	99RC41	1	BUC 3 CAJ.IZDA.50X50X47 CE.NAT	32.528	32.528
RIVER/C.NATURAL	99RP3	1	BUC PUE.MADERA 50X50X40 CE.NA	20.396	20.396
RIVER/C.NATURAL	99RP2	1	BUC PUE.MADERA 50X50X32 CE.NA	18.792	18.792
RIVER/C.NATURAL	99RP1	1	BUC PUE.MADERA 50X50X25 CE.NA	17.140	17.140
RIVER/NEGRO	09R24T	1	ZOCALO 50X45	3.184	3.184
RIVER/NEGRO	09R23T	1	ZOCALO 50X39	2.818	2.818
RIVER/NEGRO	09R22T	1	ZOCALO 50X31	2.394	2.394
RIVER/NEGRO	09R21T	1	ZOCALO 50X24	2.029	2.029
A+Z/CER.NA	97C391	1	MODULO 2289X990X585 6 ESTANTES	62.353	62.353
A+Z/CER.NA	97CR21	1	MODUL.2069X450X210 5 EST.C/RUE	27.355	27.355
A+Z/NEGRO	07RUNEG	1	JUEGO DOS RUEDAS NEGRAS	0	
A+Z/NATURAL	37H70	1	ESCRITORIO COMFAS NATURAL	86.373	86.373
CONCERT/CEREZO	54MA412	1	BUC PTA MADERA IZD 60X70X445	26.300	26.300
CONCERT/CEREZO	54MA413	1	BUC PTA MADERA DCH 60X70X445	26.300	26.300
CONCERT/CEREZO	54MA450	1	BUC 70X60X445 CAJ.1 P. 3 GR.	34.691	34.691
CONCERT/CEREZO	54ZO8	3	PATAS REGULABLES (300. BE 41	546	1.638
CONCERT/CEREZO	54EN22	1	ENCIMERA 18241465 CEREZO	9.303	9.303
A+Z/NATURAL	37H56	1	PAPALLONA MESA 180X110 NATURAL	96.466	96.466
A+Z/NATURAL	37S1	4	SILLA DU9	0	
A+Z/NEGRO	07A751C	4	TAP.GRUP.C MICROVIN 42	21.009	84.036

4. project drawings

- **plans**
- **front**
- **perspective**



To illustrate each EXPRESS component in the project_definition schema, it is used a simple example, which is the cabinet in the Figure 2, on a wall that represents one side of a room. The figure below illustrates this example:

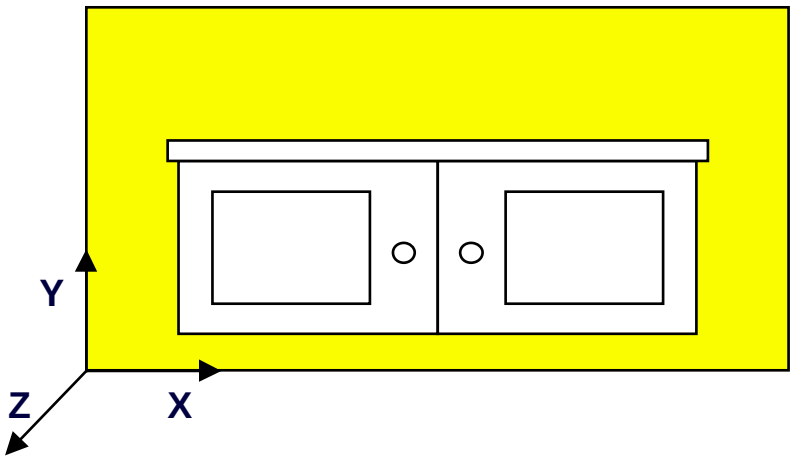


Figure E. 14 Example of one cabinet in a wall of a room

In this project all the measures are in *millimeters (mm)*

E.7.1 Type definitions

E.7.1.1 Type KIND_OF_ROOM_PART

Identifies all the parts that can exist in a room.

EXPRESS Specification:

```
*)
TYPE kind_of_room_part = ENUMERATION OF ( wall, floor, spur, housing, window, door,
roof, ceiling  );
END_TYPE;
(*
```

For the example in the Figure E. 14, there is only one wall as part of the room where is placed the cabinet, so the value selected is *wall*

E.7.2 Entity definitions

E.7.2.1 Entity PLAN_PROJECT

The furnishing project consisting of three parts: the header, catalogue and products information, and also the space definition.

EXPRESS Specification:

```
*)
ENTITY plan_project;
  info : header;
  catalogues : SET [1:?] OF catalogue_id;
  space_definition : space_definition;
 END_ENTITY;
(*
```

Figure E. 15 shows the EXPRESS-G specification for the entity plan_project.

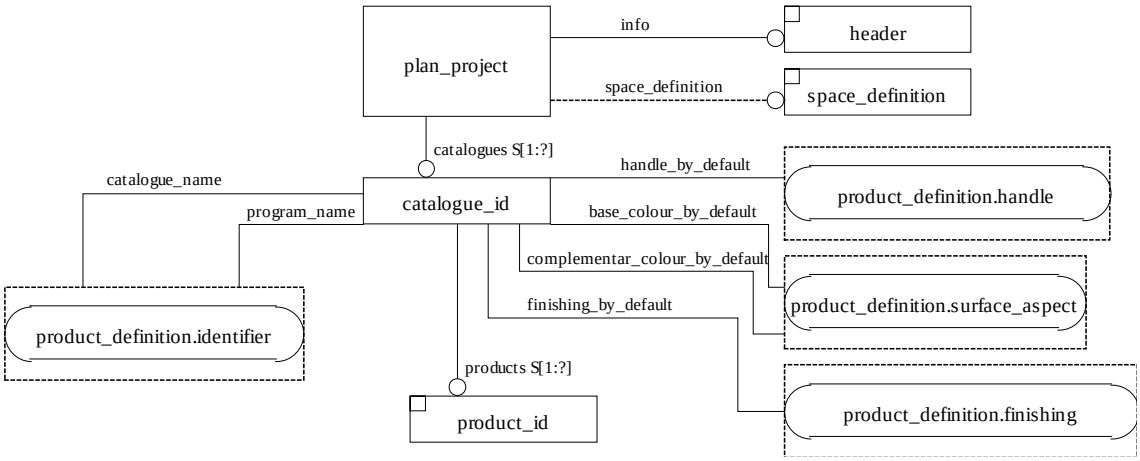


Figure E. 15 Entity-level of the entity plan_project, catalogue_id and room.

Attribute definitions:

info: the information in the header; dates, version, etc.

catalogues: the set with the identification of the catalogues used in this project.

space_definition: the definition of the space in terms of walls, floor, ceiling, etc.

E.7.2.2 Entity HEADER

General Information referring to versions, dates, addresses, etc.

EXPRESS Specification:

```
*)
ENTITY header;
  total_price : REAL;
  dealer_bank : bank;
  supplier_bank : bank;
  version : identifier;
  application : label;
  currency : label;
  terms_of_payment : text;
  percentage_details : text;
  order_number : label;
  creation_date : date_and_time;
  order_date : date_and_time;
  agreed_delivery : date_and_time;
  first_delivery : date_and_time;
  dealer_number : identifier;
  delivery_contact : contact;
```

```
  dealer_contact : contact;
  supplier_contact : contact;
  observations : text;
 END_ENTITY;
(*
```

Figure E. 16 shows the EXPRESS-G specification for the entity header.

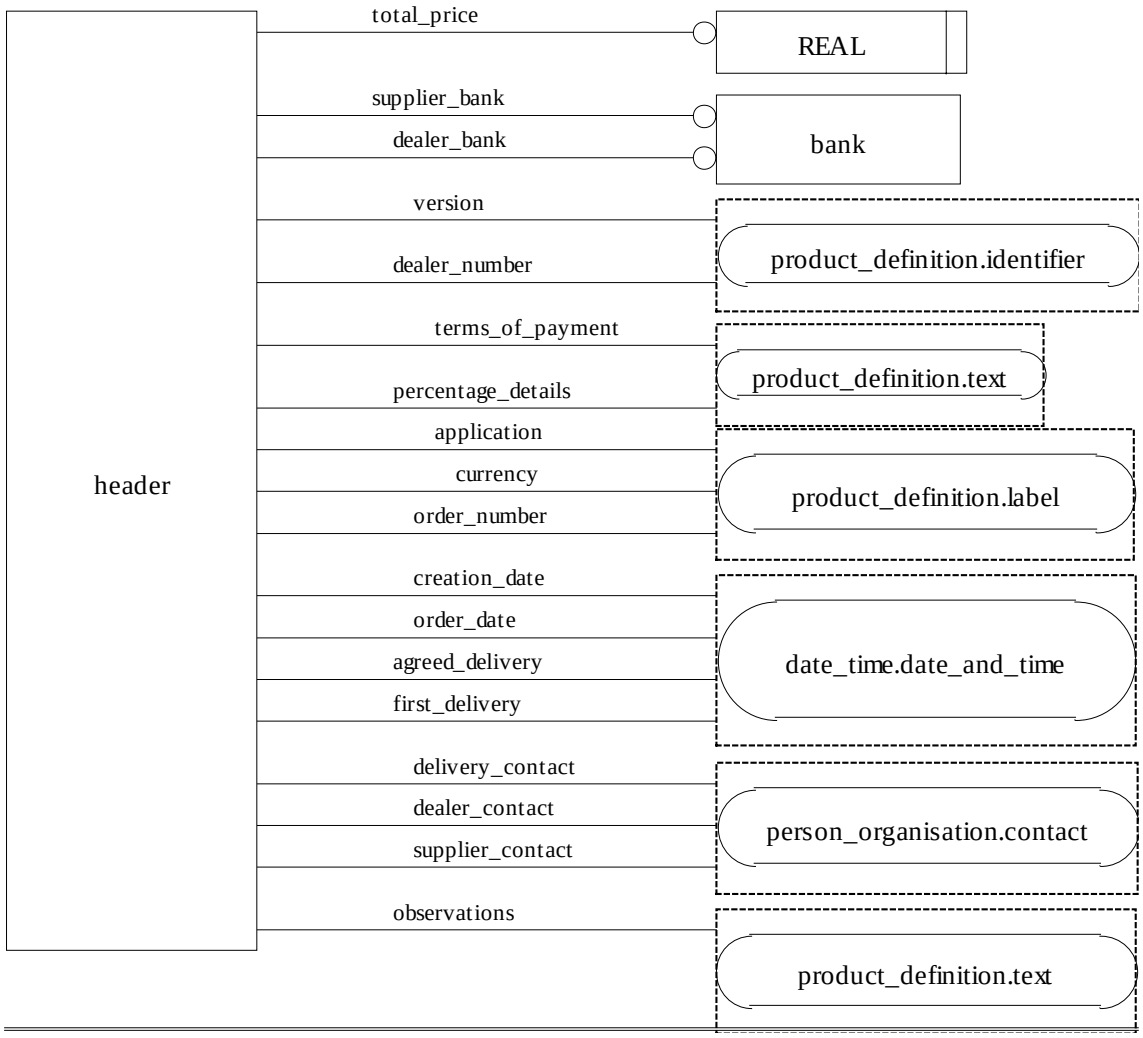


Figure E. 16 Entity-level of the entity header.

Attribute definitions:

total_price : the amount of money to pay for the project.

version: the release of a piece of software, event, etc.

application: a program designed to perform a particular task for the user, for example a CAD application.

creation_date: date of creation of the data to be delivered, date of edition.

order_number: it is an identifier, an alphanumeric string which allows an individual order to be identified.

order_date: the date of the order.

agreed_delivery: date of the delivery.

first_delivery: delivery date.

currency: the currency coding in which the prices are defined.

terms_of_payment: the conditions how the manufacturer or supplier is paid for the furniture items.

percentage_details: specifying discounts, interest, penalty and installation percentage.

dealer_number: it is an identifier, an alphanumeric string which allows an individual dealer to be identified.

supplier_bank: the data of the supplier's bank.

dealer_contact: the place and person to contact in the dealer side.

dealer_bank: the data of the dealer's bank.

delivery_contact: the place and person to contact to deliver the goods.

supplier_contact : the place and person to contact in the supplier side.

observations: general comments about the project.

As an example, the project of the Figure E. 14 has some the following header information:

- *total_price* "449,40"
- *dealer_bank* "Furniture Dealer Bank - FDB"
- *supplier_bank* "Furniture Supplier Bank – FSB"
- *version* "2.1b"
- *application* "Furniture CAD"
- *currency* "Euro"
- *terms_of_payment* "half of the total costs are paid at beginning of project and the remainder at the end of delivery"
- *percentage_details* "10% discount and 5% for the installation"
- *order_number* "0102WS"
- *creation_date* "23/05/99"
- *order_date* "01/04/99"
- *agreed_delivery* "10/06/99"
- *dealer_number* "23ASD12"
- *observations* "project for a simple cabinet for a kitchen"

E.7.2.3 Entity SPACE_DEFINITION

Information about the space where to display the products of the project, walls, floor, ceiling, or just the products "in open space". This representation can be defined in 2D or 3D.

EXPRESS Specification:

```
*)
ENTITY space_definition;
  preferential_view : camera_P46;
  label : label_AP201;
  product_position : SET [0:?] OF product_position;
  parts : LIST [0:?] OF room_part;
  definition_3D : OPTIONAL space_in_3D;
  definition_2D : OPTIONAL space_in_2D;
  position : referential;
 END_ENTITY;
(*
```

Figure E. 17 shows the EXPRESS-G specification for the entity space_definition.

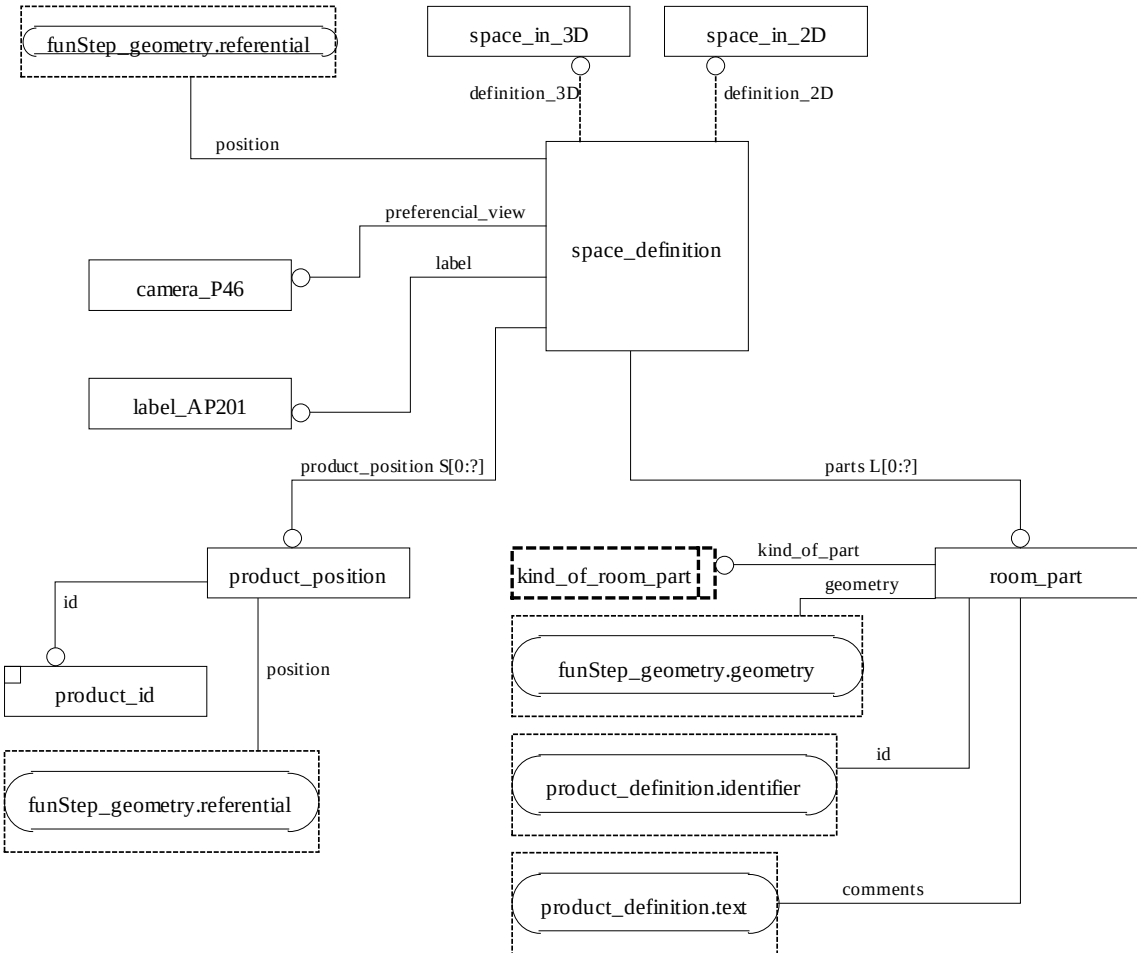


Figure E. 17 Entity-level of the entity space_definition, product_position and room_part.

Attribute definitions:

preferential_view : enable to specify a view of the space to best view the products distributed in the space.

label : a piece of text that describes some area of the space.

product_position : a set of product id's and they location in relation to the space.

parts : a list of room parts that compose the limits of the space, for example walls, floor, ceiling, etc.

definition_3D : the geometric representation of the space in 3D from AP225

definition_2D : the geometric representation of the space in 2D from AP201

position: the start point to design the space, it is the referential point for the project scene.

For the example of the project of the Figure E. 14, it has a view in front of the wall and cabinet for a better view of the scene. The scene has a label to describe it (illustrated below in ENTITY label). The space definition also defines the position of the cabinet, defined below in ENTITY product_position, and the list of room parts has the wall definition of the project in Figure E. 14. The geometric representation of the space, the only wall, is defined in the attribute definition_2D. The referential position of the room is the origin of the space: X: 0; Y: 0; Z: 0, in the coordinate axis as represented in the Figure E. 14

E.7.2.4 Entity LABEL_AP201

Represents the term by which something may be referred to. It is a string that represents the human-interpretable name of something and shall have a natural-language meaning. This definition is from the AP201,

EXPRESS Specification:

```
*)
ENTITY label_AP201;
END_ENTITY;
(*
```

Figure E. 17 shows the EXPRESS-G specification for the entity label_AP201.

In the example of the project described in Figure E. 14, the label to show in the scene is:

> "A kitchen worktop placed in a wall of the kitchen. The cabinet also has two doors and a corpus."

E.7.2.5 Entity CAMERA_P46

Describes a point of view to observe the distribution of the products in the space. This definition is from the Part 46.

EXPRESS Specification:

```
*)
ENTITY camera_P46;
END_ENTITY;
(*
```

Figure E. 17 shows the EXPRESS-G specification for the entity camera_P46.

E.7.2.6 Entity SPACE_IN_3D

Defines the geometry of the space in 3D, from the AP225.

EXPRESS Specification:

```
*)
ENTITY definition_3D;
END_ENTITY;
(*
```

Figure E. 17 shows the EXPRESS-G specification for the entity space_in_3D.

E.7.2.7 Entity SPACE_IN_2D

Defines the geometry of the space in 2D, from the AP201.

EXPRESS Specification:

```
*)
ENTITY definition_2D;
END_ENTITY;
(*
```

Figure E. 17 shows the EXPRESS-G specification for the entity space_in_2D.

E.7.2.8 Entity PRODUCT_POSITION

Defines where each product is located in the space definition relative to the space referential.

EXPRESS Specification:

```
*)
ENTITY product_position;
  position : referential;
  id : product_id;
 END_ENTITY;
(*
```

Attribute definitions:

position: the referential that indicates the position

id: the product identifier which is located by this referential

Figure E. 17 shows the EXPRESS-G specification for the entity product_position.

The product position of the cabinet “kitchen worktop” for the project in Figure E. 14, identified by “KTWKT0199”, is the referential position X: 34; Y: 0; Z: 0 relative to the coordinate of the room.

E.7.2.9 Entity ROOM_PART

A part of the room that limits the space of the project. This part can be a wall or partitions of it, floor and ceiling.

EXPRESS Specification:

```
*)
ENTITY room_part;
  geometry : geometry;
  kind_of_part : kind_of_room_part;
  id : identifier;
  comments : text;
 END_ENTITY;
(*
```

Attribute definitions:

geometry : the geometric representation of the part, with lines and points.

kind_of_part : an enumerated value that defines which part is this.

id : the part identifier in this space definition.

comments : comments about the part.

Figure E. 17 shows the EXPRESS-G specification for the entity room_part.

In the project of the Figure E. 14, a room_part is the wall. This room part is described by it's geometric representation: points and lines; the identifier "67FW01", and the kind of room part is: *wall*. The comment for this room part is "the front wall of the room".

E.7.2.10 Entity CATALOGUE_ID

The identification information about a catalogue used in the project. It contains the identification about the default values for the attributes to apply from the catalogue, name of the program and catalogue, which it refers to. It also has a set of product identifiers used in this project that are "under" the catalogues.

EXPRESS Specification:

```
*)
ENTITY catalogue_id;
  products : SET [1:?] OF product_id;
  handle_by_default : type_of_handle;
  base_colour_by_default : surface_aspect;
  complementary_colour_by_default : surface_aspect;
  program_name : identifier;
  catalogue_name : identifier;
  finishing_by_default : type_of_finishing;
 END_ENTITY;
(*
```

Attribute definitions:

products : a set of product identifiers, which compose the plan project.

handle_by_default : the handle type definition used in this project

base_colour_by_default : the base colour definition used in this project

complementary_colour_by_default : the complementary colour definition used in this project

program_name : the name of the program used in this project

catalogue_name : the name of the catalogue used in this project

finishing_by_default : the finishing definition used in this project

Figure E. 15 shows the EXPRESS-G specification for the entity catalogue_id.

The project, which is illustrated in Figure E. 14, has a catalogue associated to it, which is identified by this ENTITY. This ENTITY describes the product in the project and the attributes applied to the products: handles, colours and finishing. The catalogue also has a name: “kitchen demo”, and the name of the program in the catalogue associated to the project is “kitchen line”.

E.7.2.11 Entity PRODUCT_ID

The identification information about the products used in the project. It contains the product identification and enables to define the variations in terms of attributes. If it is a special product, it also defines the variations in terms of product measures.

EXPRESS Specification:

```
*)
ENTITY product_id;
  possible_variants : SET [1:?] OF variants;
  quantity : INTEGER;
  id : identifier;
  start_of_ cut: referential
 END_ENTITY;
(*
```

Attribute definitions:

possible_variants : a set of variations in terms of attributes in the program

quantity : number of these products in the project

id : identifier of the product in the catalogue.

start_of_cut : the referential point where to initiate the cut operation on the product.

Figure E. 18 shows the EXPRESS-G specification for the entity product_id, special_product and variants.

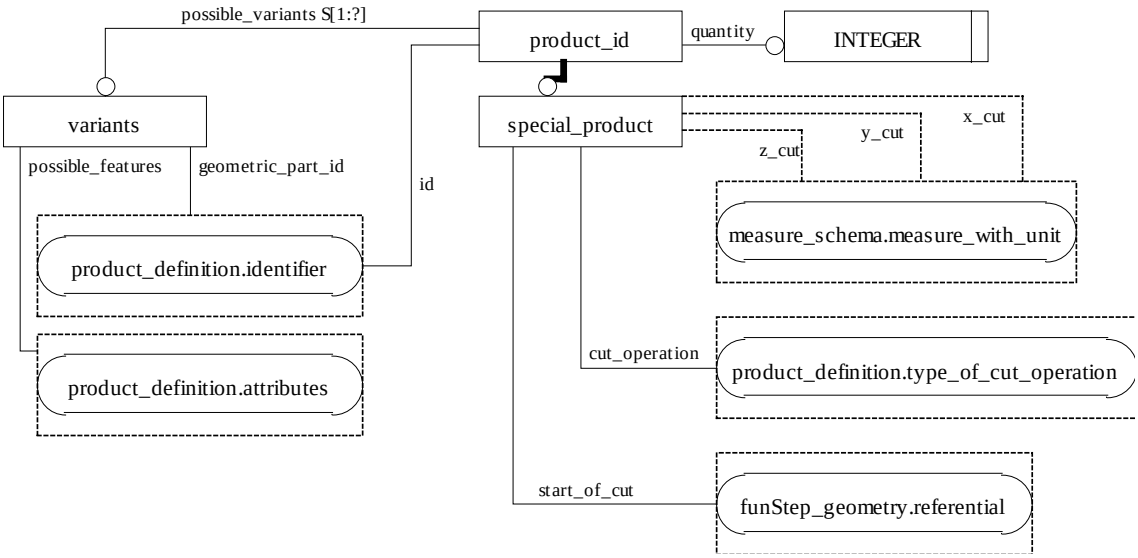


Figure E. 18 Entity-level of the entity product_id, special_product and variants.

In the project of the Figure E. 18, the product " kitchen worktop" identified by "KTWKT0199" can have some differences in the surface aspect from the product in catalogue. Also is specified the quantity of the product that the project contains, although only one is displayed in the scene of the Figure E. 18.

E.7.2.12 Entity SPECIAL_PRODUCT

Identifies the cut operations, if any, in the product, and the maximum cut measures allowed to be performed in the product.

EXPRESS Specification:

```
*)
ENTITY special_product
  SUBTYPE OF (
   product_id
  );
  x_cut : OPTIONAL measure_with_unit;
  y_cut : OPTIONAL measure_with_unit;
  z_cut : OPTIONAL measure_with_unit;
  cut_operation : type_of_cut_operation;
  start_of_cut : referential;
 END_ENTITY;
(*
```

Attribute definitions:

x_cut : the maximum X cut measure allowed for this product

y_cut : the maximum Y cut measure allowed for this product

z_cut : the maximum Z cut measure allowed for this product

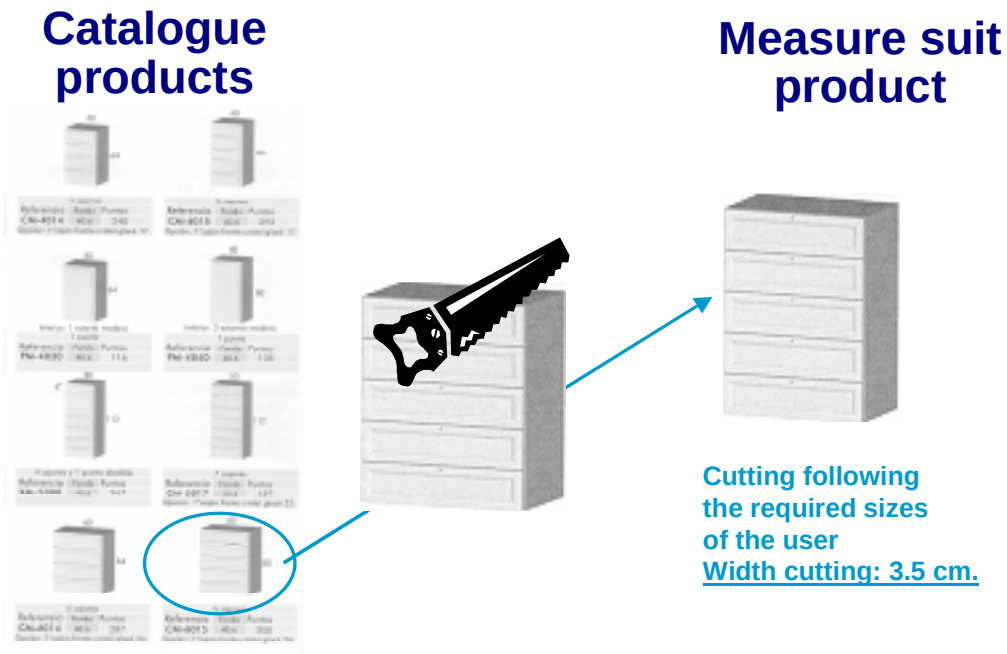
cut_operation : the enumeration value of the cut operation to be done in the special product

start_of_cut: the referential position relative to the product where to start the cut operation.

Figure E. 18 shows the EXPRESS-G specification for the entity special_product.

The project in the Figure E. 14 can have a product that has a geometry modification relative to the product in catalogue. Imagine that the special product takes a cut in depth: X: 0; Y: 5; Z: 0; at the reference point: X: 0; Y: 0; Z: 0. These measures must follow the maximum cut measures specified in the ENTITY measure_suit_operation.

Another example of a special product is represented in the picture below.



E.7.2.13 Entity VARIANTS

Defines the new surface aspect of one geometric part of the product relative to the program attributes in the catalogue.

EXPRESS Specification:

```
*)
ENTITY variants;
  geometric_part_id : identifier;
  possible_attributes : attributes;
 END_ENTITY;
(*
```

Attribute definitions:

geometric_part_id : the identifier of the geometric part that aspect is different from that specified in the program of the catalogue.

possible_attributes : the feature to apply on the geometric part which aspect is different from the one defined by the program in the catalogue.

Figure E. 18 shows the EXPRESS-G specification for the entity variants.

One variant for the project in Figure E. 14 is to change the colour of the worktop part of the “kitchen worktop”. The identifier of the worktop is “01GP23WT99” and the new feature to apply is one base colour, which is *white* (255 255 255).

E.8 Annex I: ARM EXPRESS Short form

```
SCHEMA product_definition;
 REFERENCE FROM funStep_geometry (
  geometry
 );
 REFERENCE FROM funStep_geometry (
  referential
 );
 REFERENCE FROM measure (
  measure_with_unit
 );
 REFERENCE FROM person_organisation (
  contact
 );
 REFERENCE FROM date_time (
  date_and_time
 );

 TYPE kind_of_product = ENUMERATION OF ( bed, accessory, appliance,
corpus, module_base, seat_furniture, sink, table, worktop, shelf,
door, drawer   );
 END_TYPE;

 TYPE type_of_measure = ENUMERATION OF ( unitary, linear_meter,
square_meter  );
 END_TYPE;

 TYPE type_of_currency = ENUMERATION OF ( value_in_points, PTE, DME,
ESC, EURO, US_Dollars  );
 END_TYPE;

 TYPE type_of_price_factor = ENUMERATION OF ( fixed_price, percentage
);
 END_TYPE;

 TYPE text = STRING;
 END_TYPE;

 TYPE identifier = STRING;
 END_TYPE;

 TYPE label = STRING;
 END_TYPE;

 TYPE type_of_cut_operation = ENUMERATION OF ( column, beam, height,
depth, width  );
 END_TYPE;

 ENTITY furniture_supplier;
  addresses : SET [1:?] OF contact;
  offered_catalogues : SET [1:?] OF catalogue;
  vat_number : identifier;
  commercial_name : label;
  fiscal_name : label;
 END_ENTITY;

 ENTITY catalogue;
  programs : SET [1:?] OF program;
  name : label;
  description : text;
  valid_from : date_and_time;
 END_ENTITY;

 ENTITY program;
  products : SET [1:?] OF program_product;
  attributes : SET [1:?] OF attributes;
  price_group : identifier;
```

```
 END_ENTITY;

 ENTITY program_product;
  price : price;
  product : catalogue_product;
  id : identifier;
 END_ENTITY;

 ENTITY price;
  measure_unit : type_of_measure;
  price_per_unit : REAL;
  currency_unit : type_of_currency;
 END_ENTITY;

 ENTITY catalogue_product
-- missing Supertype Expression
 ABSTRACT SUPERTYPE;
  kind_of_product : kind_of_product;
  size : boundary_box;
  required_space : OPTIONAL boundary_box;
  operations : SET [0:?] OF measure_suit_operation;
  code : identifier;
  name : label;
  position : referential;
  inhouse_id : OPTIONAL identifier;
  description : text;
  short_name : label;
 END_ENTITY;

 ENTITY composite_product
  SUBTYPE OF (
   catalogue_product
  );
  product_parts : SET [1:?] OF catalogue_product;
 END_ENTITY;

 ENTITY simple_product
  SUBTYPE OF (
   catalogue_product
  );
  geometry : geometry;
 END_ENTITY;

 ENTITY boundary_box;
  width : measure_with_unit;
  height : measure_with_unit;
  depth : measure_with_unit;
 WHERE


 END_ENTITY;

 ENTITY measure_suit_operation;
  price_factor : price_factor;
  comments : text;
  drawing : BOOLEAN;
  x_cut_max : OPTIONAL measure_with_unit;
  y_cut_max : OPTIONAL measure_with_unit;
  z_cut_max : OPTIONAL measure_with_unit;
  alowed_operation : type_of_cut_operation;
 END_ENTITY;

 ENTITY price_factor;
  type_of_price_factor : type_of_price_factor;
  price_factor_value : REAL;
 END_ENTITY;

 ENTITY attributes
-- missing Supertype Expression
 ABSTRACT SUPERTYPE;
```

```
END_ENTITY;

ENTITY base_colour_attributes
 SUBTYPE OF (
  attributes
 );
 available_colours : SET [1:?] OF surface_aspect;
END_ENTITY;

ENTITY complementary_colour_attributes
 SUBTYPE OF (
  attributes
 );
 available_colours : SET [0:?] OF surface_aspect;
 applied_to : SET OF kind_of_product;
END_ENTITY;

ENTITY handle_attributes
 SUBTYPE OF (
  attributes
 );
 available_handles : SET [0:?] OF handle;
END_ENTITY;

ENTITY fabrics_attributes
 SUBTYPE OF (
  attributes
 );
 applied_to : SET [0:?] OF kind_of_product;
 available : SET [0:?] OF fabrics;
END_ENTITY;

ENTITY surface_aspect
-- missing Supertype Expression
ABSTRACT SUPERTYPE;
END_ENTITY;

ENTITY finishing_attributes
 SUBTYPE OF (
  attributes
 );
 available_finishings : SET [0:?] OF finishing;
END_ENTITY;

ENTITY handle;
 geometry : geometry;
 id : identifier;
END_ENTITY;

ENTITY fabrics;
 id : identifier;
 aspect : surface_aspect;
 fabric_group_id : identifier;
END_ENTITY;

ENTITY rgb
 SUBTYPE OF (
  surface_aspect
 );
 red : INTEGER;
 blue : INTEGER;
 green : INTEGER;
END_ENTITY;

ENTITY texture_mapping
 SUBTYPE OF (
  surface_aspect
 );
 image_file_name : label;
END_ENTITY;
```

```
 ENTITY finishing;
  geometry : geometry;
  id : identifier;
 END_ENTITY;

END_SCHEMA;


SCHEMA project_definition;
 REFERENCE FROM product_definition (
  surface_aspect
 );
 REFERENCE FROM product_definition (
  handle
 );
 REFERENCE FROM product_definition (
  identifier
 );
 REFERENCE FROM product_definition (
  attributes
 );
 REFERENCE FROM product_definition (
  type_of_cut_operation
 );
 REFERENCE FROM product_definition (
  text
 );
 REFERENCE FROM product_definition (
  label
 );
 REFERENCE FROM product_definition (
  finishing
 );
 REFERENCE FROM funStep_geometry (
  referential
 );
 REFERENCE FROM funStep_geometry (
  geometry
 );
 REFERENCE FROM measure (
  measure_with_unit
 );
 REFERENCE FROM person_organisation (
  contact
 );
 REFERENCE FROM date_time (
  date_and_time
 );

 TYPE  kind_of_room_part  =  ENUMERATION  OF  (  wall,  floor,  spur,
housing,window, door, roof, ceiling  );
 END_TYPE;

 ENTITY plan_project;
  info : header;
  catalogues : SET [1:?] OF catalogue_id;
  space_definition : OPTIONAL space_definition;
 END_ENTITY;

 ENTITY header;
  total_price : REAL;
  dealer_bank : bank;
  supplier_bank : bank;
  version : identifier;
  application : label;
  currency : label;
  order_number : label;
  creation_date : date_and_time;
  order_date : date_and_time;
```

```
 agreed_delivery : date_and_time;
 first_delivery : date_and_time;
 dealer_number : identifier;
 delivery_contact : contact;
 dealer_contact : contact;
 supplier_contact : contact;
 observations : text;
 terms_of_payment : text;
 percentage_details : text;
END_ENTITY;

ENTITY catalogue_id;
 products : SET [1:?] OF product_id;
 handle_by_default : handle;
 base_colour_by_default : surface_aspect;
 complementar_colour_by_default : surface_aspect;
 program_name : identifier;
 catalogue_name : identifier;
 finishing_by_default : finishing;
END_ENTITY;

ENTITY product_id;
 possible_variants : SET [1:?] OF variants;
 quantity : INTEGER;
 id : identifier;
END_ENTITY;

ENTITY variants;
 geometric_part_id : identifier;
 possible_features : attributes;
END_ENTITY;

ENTITY special_product
 SUBTYPE OF (
  product_id
 );
 x_cut : OPTIONAL measure_with_unit;
 y_cut : OPTIONAL measure_with_unit;
 z_cut : OPTIONAL measure_with_unit;
 cut_operation : type_of_cut_operation;
 start_of_cut : referential;
END_ENTITY;

ENTITY space_definition;
 preferencial_view : camera_P46;
 label : label_AP201;
 product_position : SET [0:?] OF product_position;
 parts : LIST [0:?] OF room_part;
 definition_3D : OPTIONAL space_in_3D;
 definition_2D : OPTIONAL space_in_2D;
 position : referential;
END_ENTITY;

ENTITY camera_P46;
END_ENTITY;

ENTITY label_AP201;
END_ENTITY;

ENTITY product_position;
 position : referential;
 id : product_id;
END_ENTITY;

ENTITY room_part;
 geometry : geometry;
 kind_of_part : kind_of_room_part;
 id : identifier;
 comments : text;
END_ENTITY;
```

```
 ENTITY space_in_2D;
 END_ENTITY;

 ENTITY space_in_3D;
 END_ENTITY;

 ENTITY bank;
 END_ENTITY;

END_SCHEMA;


SCHEMA funStep_geometry;
 REFERENCE FROM product_definition (
  identifier
 );

 TYPE   applied_surface_aspect   =   ENUMERATION   OF   (   base_colour,
complemtary_colour,        fabric,        base_and_complemntary_colours,
base_colour_and_fabric,                complementary_colour_and_fabric,
base_and_complementary_colours_and_fabric  );
 END_TYPE;

 ENTITY geometry;
  parts : SET [1:?] OF geometry_part;
 END_ENTITY;

 ENTITY geometry_part;
  position : referential;
  geometry_definition : Part_42;
  surface_aspect : applied_surface_aspect;
  geometry_part_id : identifier;
 END_ENTITY;

 ENTITY referential;
 END_ENTITY;

 ENTITY Part_42;
 END_ENTITY;

END_SCHEMA;


SCHEMA measure;

 ENTITY measure_with_unit;
 END_ENTITY;

END_SCHEMA;


SCHEMA person_organisation;
 REFERENCE FROM product_definition (
  label
 );

 TYPE company_type = ENUMERATION OF ( furniture_manufacturer,
furniture_representative,
retailer, big_retailer,
private_customer,
furniture_supplier_raw_material,
furniture_supplier_half_finished_products,
supplier_representative  );
 END_TYPE;

 ENTITY contact;
  country : OPTIONAL label;
  email : OPTIONAL label;
  facsmile : OPTIONAL label;
```

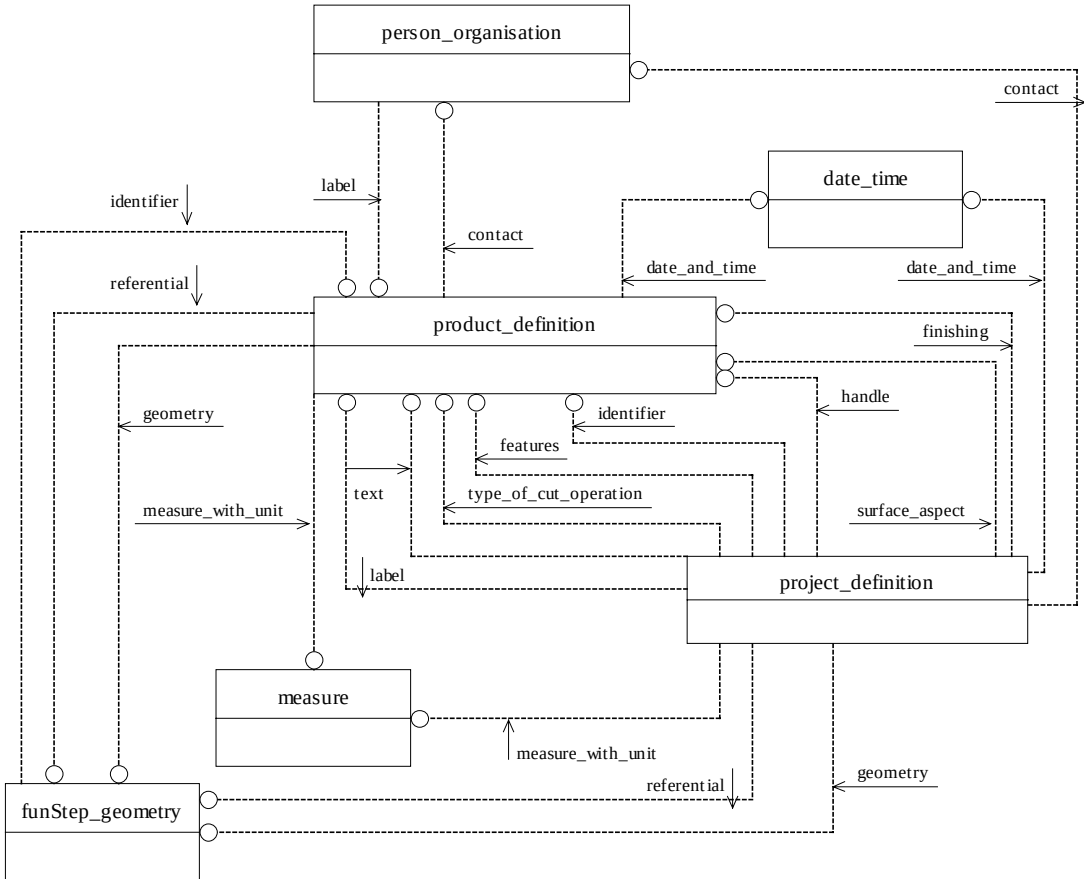
```
  internal_extension : OPTIONAL label;
  postal_box : OPTIONAL label;
  region_code : OPTIONAL label;
  street : OPTIONAL label;
  number_in_street : OPTIONAL label;
  telephone : OPTIONAL label;
  telex : OPTIONAL label;
  town : OPTIONAL label;
  person_name : OPTIONAL label;
  company_range : company_type;
 END_ENTITY;

END_SCHEMA;


SCHEMA date_time;

 ENTITY date_and_time;
 END_ENTITY;

END_SCHEMA;
```

E.9 Index

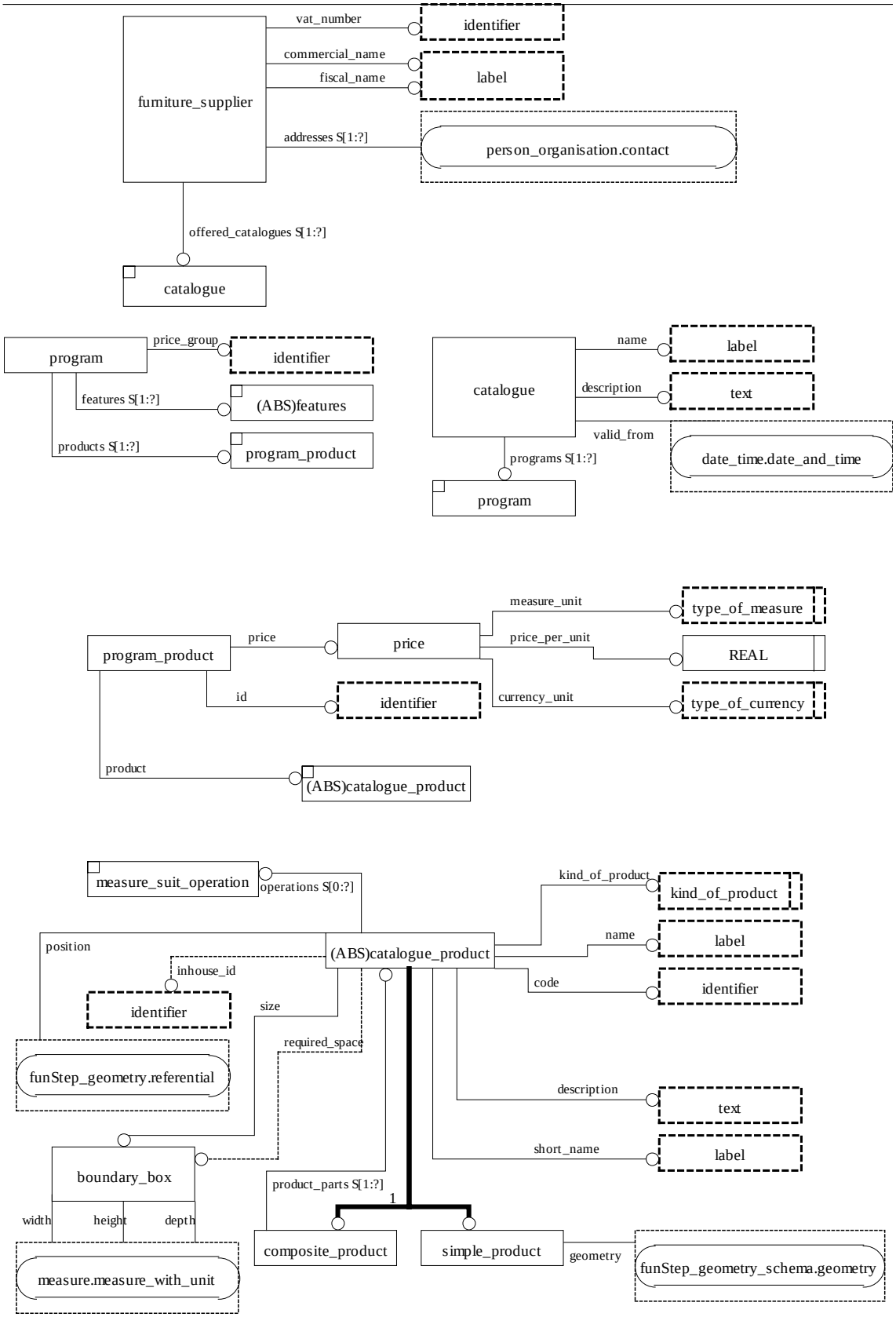
E.10 List of Figures

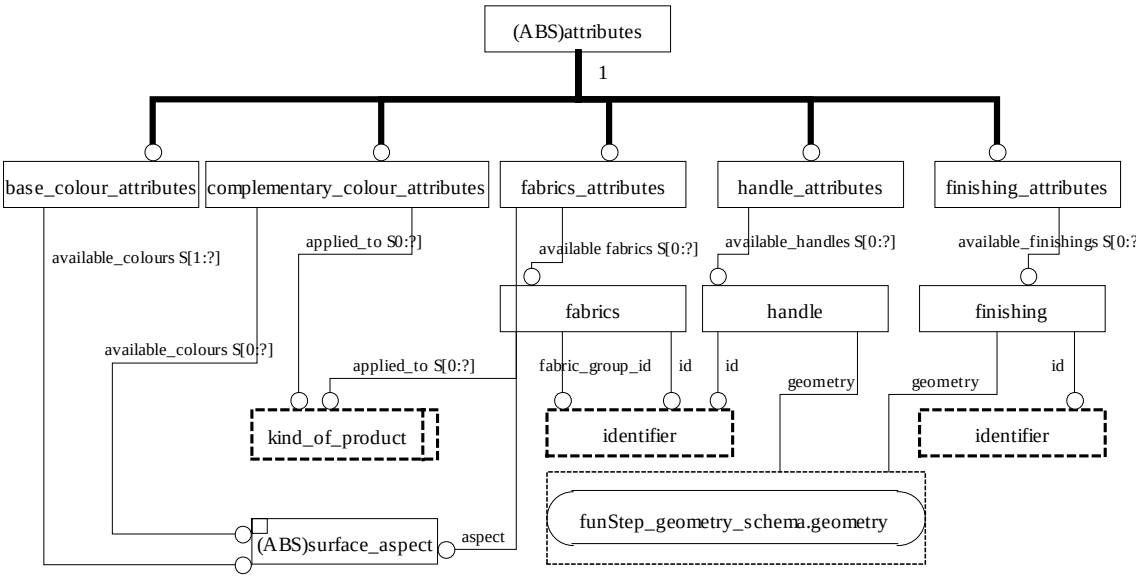
E.11 Annex II: ARM EXPRESS-G

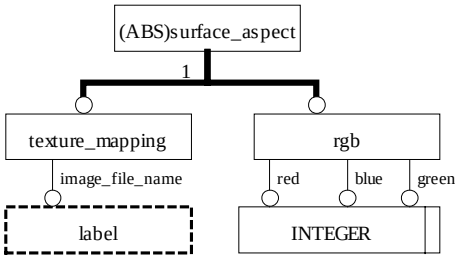
E.11.1 The EXPRESS-G of the SCHEMATA level.

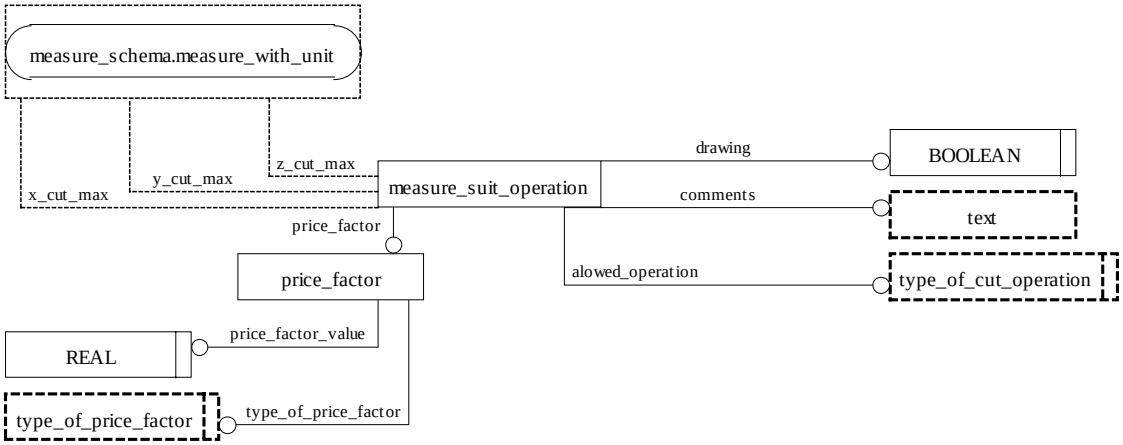


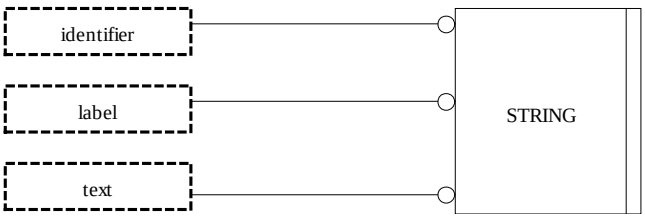
E.11.2 Product definition schema



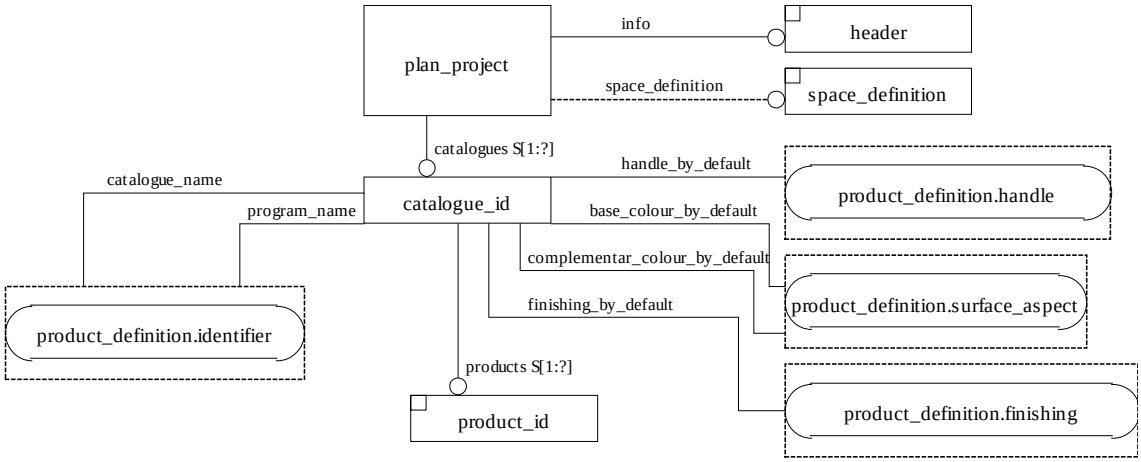

(ABS)attributes
1
base_colour_attributes
complementary_colour_attributes
fabrics_attributes
handle_attributes
finishing_attributes
available_colours S[1:?]
applied_to S0:?]
available fabrics S[0:?]
available_handles S[0:?]
available_finishings S[0:?
fabrics
handle
finishing
available_colours S[0:?]
applied_to S[0:?]
fabric_group_id
id
id
geometry
geometry
id
kind_of_product
identifier
identifier
funStep_geometry_schema.geometry
(ABS)surface_aspect
aspect

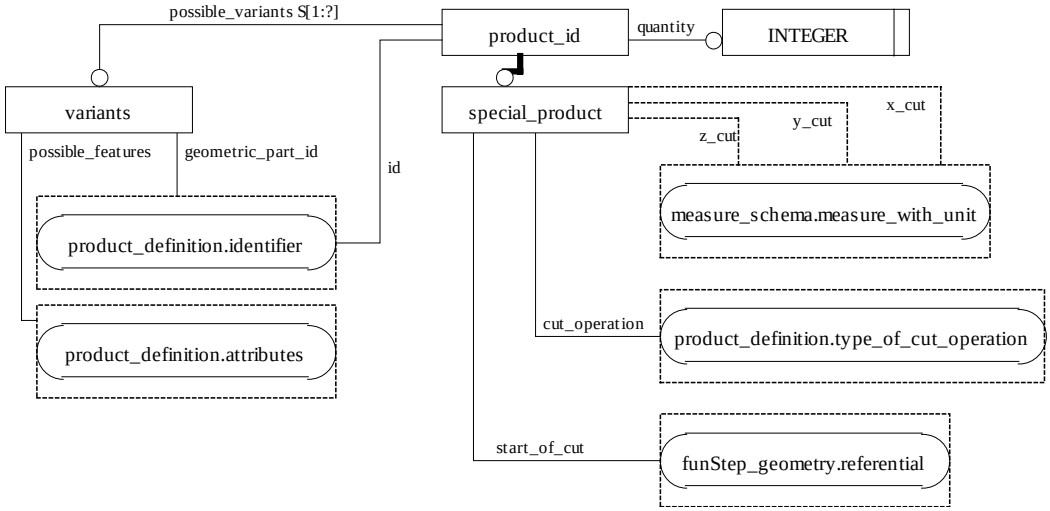

(ABS)surface_aspect
1
texture_mapping
rgb
image_file_name
red
blue
green
label
INTEGER

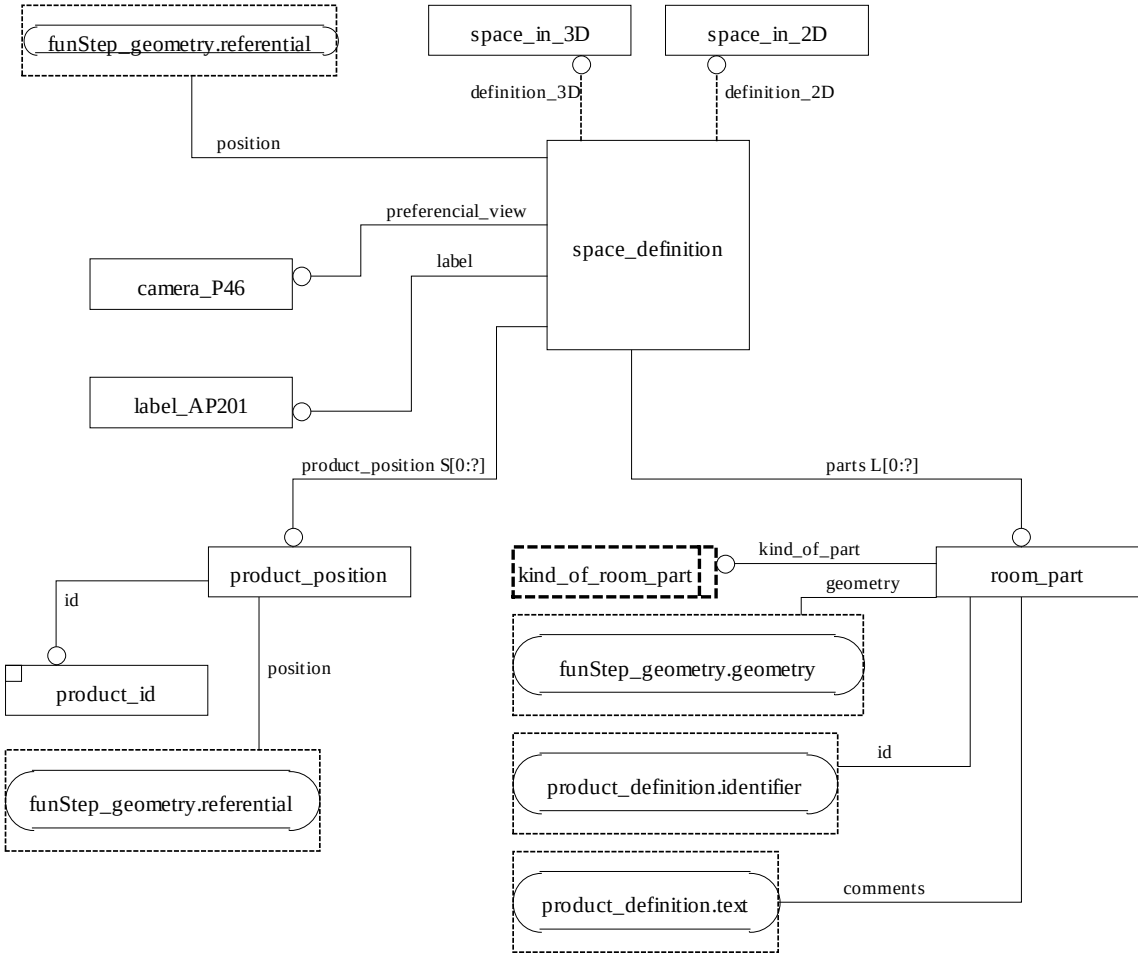

measure_schema.measure_with_unit
drawing
BOOLEAN
z_cut_max
y_cut_max
x_cut_max
measure_suit_operation
comments
text
price_factor
price_factor
alowed_operation
type_of_cut_operation
price_factor_value
REAL
type_of_price_factor
type_of_price_factor

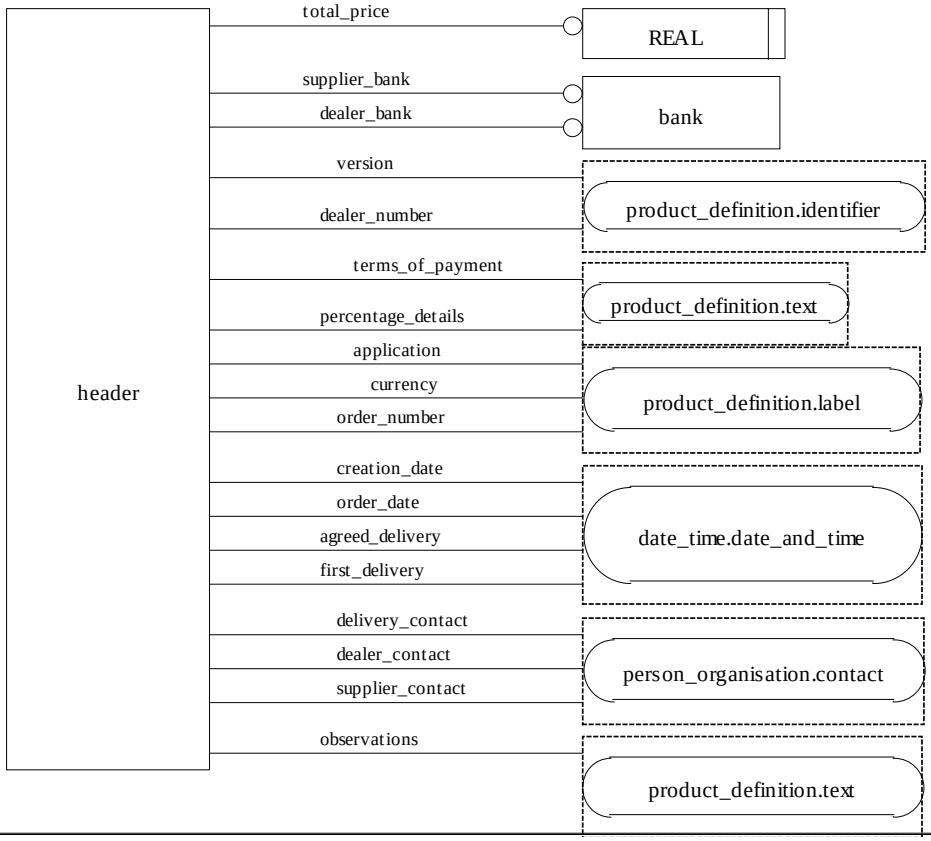

identifier
label
text
STRING

E.11.3 Project definition schema

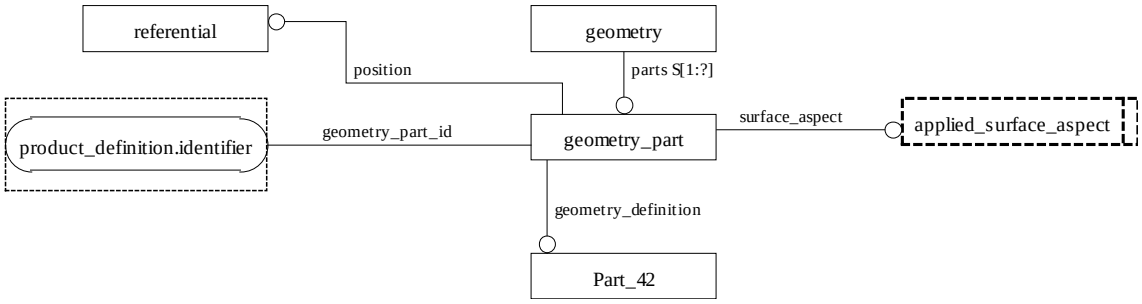




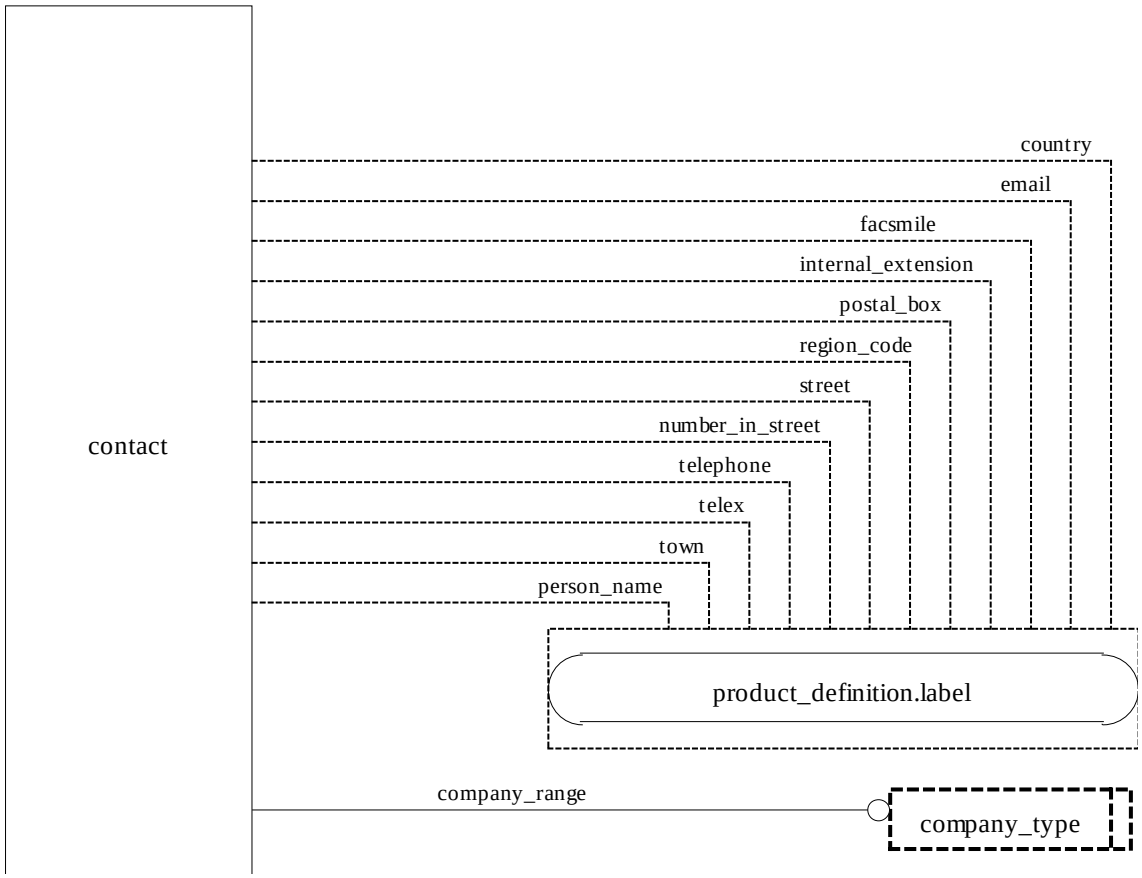

funStep_geometry.referential
space_in_3D
space_in_2D
definition_3D
definition_2D
position
preferencial_view
space_definition
camera_P46
label
label_AP201
product_position S[0:?]
parts L[0:?]
product_position
kind_of_part
kind_of_room_part
room_part
geometry
id
product_id
position
funStep_geometry.geometry
funStep_geometry.referential
product_definition.identifier
id
product_definition.text
comments


header
total_price
REAL
supplier_bank
dealer_bank
bank
version
dealer_number
product_definition.identifier
terms_of_payment
percentage_details
product_definition.text
application
currency
order_number
product_definition.label
creation_date
order_date
agreed_delivery
first_delivery
date_time.date_and_time
delivery_contact
dealer_contact
supplier_contact
person_organisation.contact
observations
product_definition.text

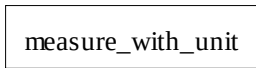
E.11.4 funStep geometry schema



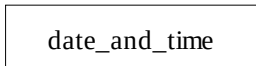
E.11.5 Person organization schema



E.11.6 Measure schema



E.11.7 Date time schema



F AIM EXPRESS-G

(informative)

G AIM EXPRESS

(informative)

H Bibliography

(informative)

- funStep project delivrables and reports
- ISO SC4 Documents
- “Standardization Sumary Main Frame – SC4 Stadardization Process”; ISO SC4; http://www.nist.gov/sc4/ss_text.html/
- Industrial furnishing catalogues
- Integration Definition For Function Modeling (IDEF0)